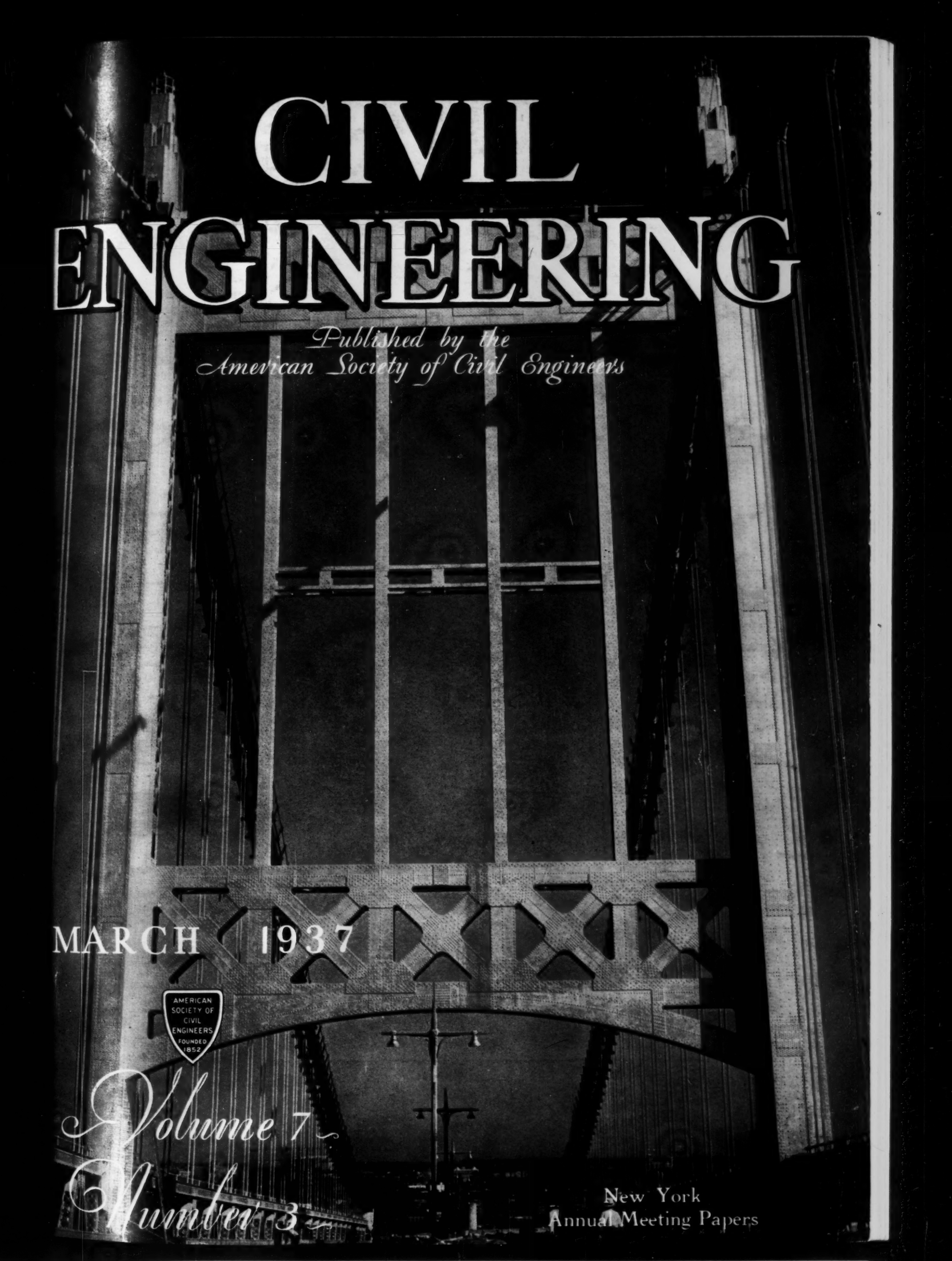

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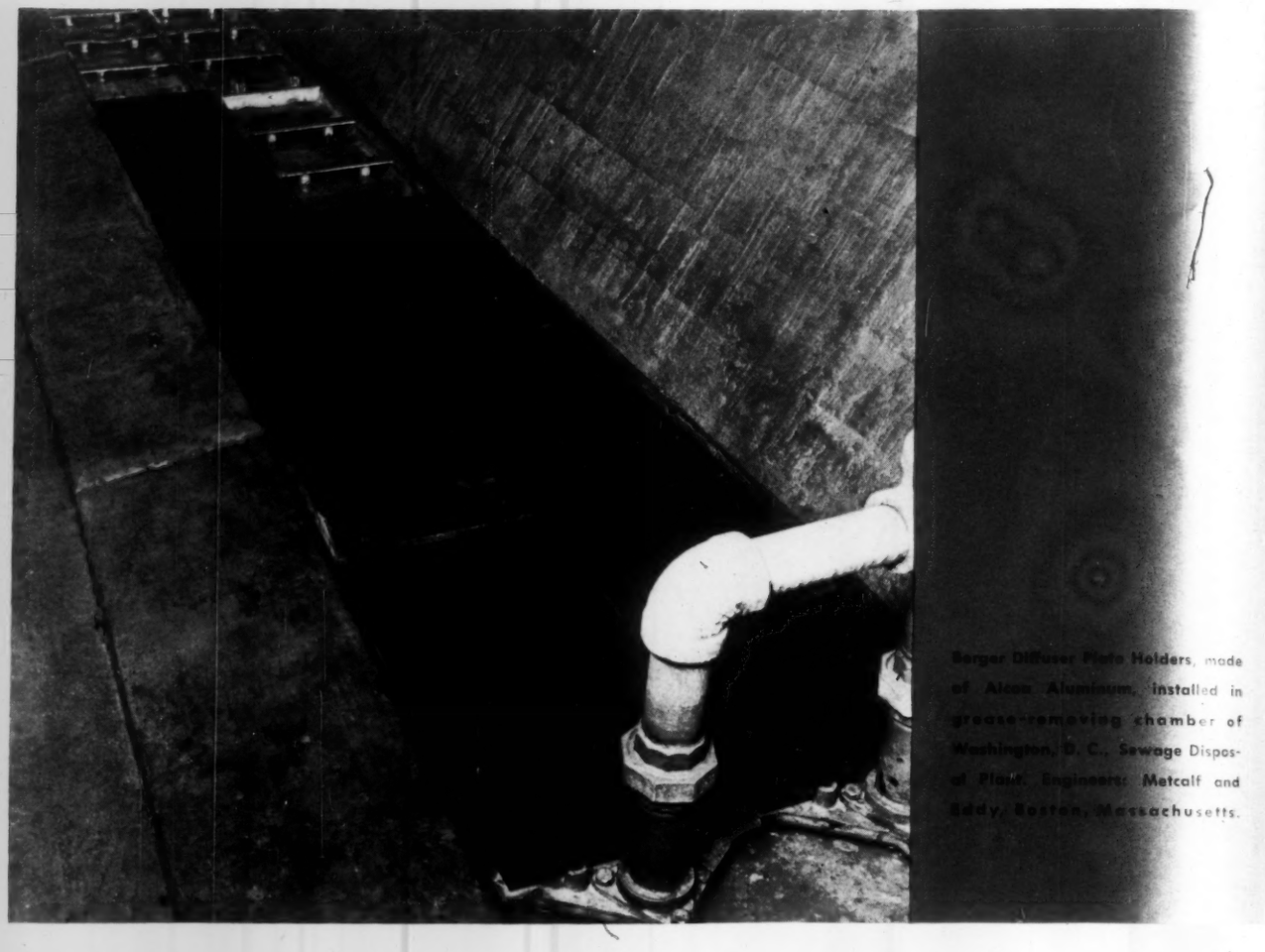

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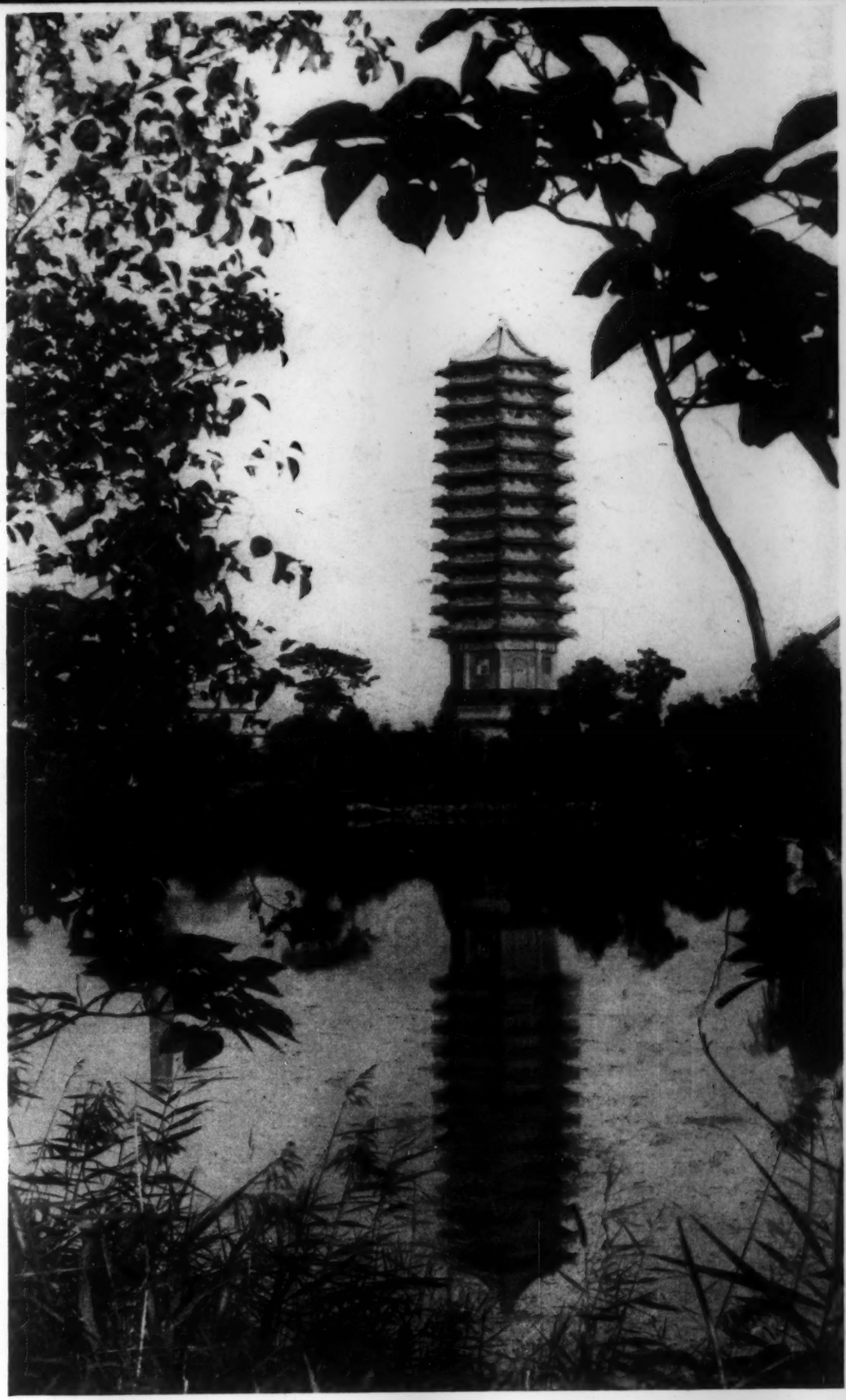

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Political Boundaries Versus Watersheds

THE March issue of PROCEEDINGS is to be devoted primarily to a symposium on flood control as presented at the Fall Meeting of the Society held in Pittsburgh in October 1936. The Committee on Publications takes this opportunity to call the attention of the membership to the fundamental questions of public policy which are discussed from several angles in these flood papers.

If engineers were called upon to suggest, in lieu of the present more or less geometrical political divisions of our states and counties, a basis for another method of division which would more closely conform to our modern industrial, economic, and political needs, the suggestion would probably be to adopt drainage areas—watershed lines—as the most suitable means of defining state and county boundaries. Many of our most important public problems of the present day are watershed, rather than county or state, problems. Notably those concerned with water supply, stream pollution, water power, and flood control—to mention a few—are of this type.

Watersheds Not on Political Lines.—Unfortunately, however, state and county boundaries are independent of watershed lines, and the possibility of so changing these existing political boundaries as to bring about such conformity is so visionary and impractical as to be unworthy of serious consideration. Some other means must be found of solving those problems which involve interstate as well as intercounty and also municipal interests.

While many purely technical matters—such as records, methods, and design—were discussed at Pittsburgh, this, as we see it, is the fundamental problem which was so earnestly debated in several of the papers of this symposium.

There are those who, noting the interstate character of the problem and believing that a complete and correspondingly costly program of construction is essential to adequate flood protection, look upon the federal government as the only agency able to ignore state boundaries and to provide the financial resources necessary for such undertakings.

There are others, however, who feel that any such move would result in continuing what they refer to as the plundering of the federal pork-barrel by local interests. When Uncle Sam, they point out, is to foot the bill for what is essentially a local work, it is inevitable that the local representatives will first compete for federal funds and will finally arrive at the only possible working basis, namely, the method of swapping appropriations without reference to actual need or economic justification. Several years ago, C. McD. Townsend, M. Am. Soc. C.E., former chairman of the Mississippi River Commission, speaking of river and harbor improvements, remarked: "Where it is a question of expenditure from the U. S. Treasury, every community will demand consideration of its local needs. An equitable distribution of funds over the entire country is necessary to insure the passage of a river and harbor bill." Appropriations for necessary works too often involve parallel appropriations of an uneconomic and wasteful type.

Where Do Federal Responsibilities End?—To meet this difficulty it has been suggested that part of the financial burden of any federal undertaking should be carried as an assessment for benefits in the local area involved. The staunch advocate of states' rights and of rigid economic justification, however, will object to this proposal as inadequate—as a palliative rather than a cure for a plan which he believes to be fundamentally wrong. How are you going to handle flood problems which are completely within state boundaries, he asks? Is the federal government going to take over intrastate as well as interstate undertakings? Is not the assumption that this is a federal problem simply a camouflage to cover up a scheme to secure federal funds for a local improvement?

In all probability he will also refer to the successful cooperation of local interests in the case of the flood works of the Miami Conservancy District, as an example of how such works should be constructed. Furthermore, he will point out, Congress can authorize interstate compacts which will permit similar concerted action by communities located on interstate watersheds.

The possibilities of the problem, however, have not been exhausted in these two conflicting statements. The engineer of broad and unbiased vision will see values in both suggestions and will thus seek a practical compromise.

After all, the problem of flood control, although it admittedly has national interest, is a watershed problem and must be economically related to local conditions, needs, and values, if it is to be carried forward on a sound, economic basis. If we recall the history of Federal Aid in the highway field, we find a hint as to the part the federal government might play in this problem.

Highway Aid as an Example.—In the earlier days of the highway era, Federal Aid was a most important element in financing much-needed highway construction. Today, however, if we omit the recent emergency relief appropriations, Federal Aid is a relatively small element in highway financing. In fact, the chief contribution made to the highway problem by the federal government has been that of forcing adequate highway organization, adequate maintenance, and, more recently, encouraging the future planning of highways by the states.

A reasonably well-organized state highway department was made an essential requirement for securing Federal Aid, and, until this was done, few states gave adequate attention to their highway problems. Even today the chief function of Federal Aid is to be found in its encouragement of sane planning and sound practice, in other words, its indirect regulatory and control powers in the highway field. Why not a similar policy for Federal Aid in the field of flood control?

Cannot federal aid for flood control be made something more than a mere plundering of federal funds for improvements which, be they intra- or inter-state, are nevertheless largely of local benefit? Some financial assistance from the federal treasury for such works is not only probably necessary but is justified by the national loss suffered through great local disasters such as those of the last few years. Such grants could be made conditional, however, on the passage of adequate state and, where necessary, interstate legislation for the control of streams—not only for flood control but also looking toward the more general economic development of our water resources. Such legislation should unquestionably include wide powers, particularly that of condemnation, so as to make possible the removal of obstructions from stream channels and the control of future construction and of water use. In many cases the continual encroachment of man on the flood channels of our streams has been the main cause for flood disasters. Some clearing of these obstructions to flow is always essential and in many cases may be found to offer the most economic solution of the flood problem.

Further provisions must also be made for the distribution of costs—through federal and state grants but primarily through assessment for benefits in the areas involved.

Solution Depends on Engineers.—It is generally recognized that the Flood Act of 1936 was an emergency measure, was indefinite and incomplete, and established no constructive policy of flood control. Recently the results of the hurried survey made by the Water Resources Committee of the National Resources Board have been turned over to the President. This report summarizes available data on the broad problems of water resources, control, and utilization in the United States. The President has sent a brief message to Congress calling attention to this problem but not offering any definite suggestions as to details of policy beyond the apparent assumption that the federal government will meet the costs. Its proper solution obviously requires full, calm, and careful study, and competent, unbiased engineering advice rather than precipitate action taken under the pressure and emotional reaction following a great disaster.

We recommend to our readers a careful reading of the papers of the Pittsburgh symposium on flood control. The Committee on Publications has authorized their printing not only because of the valuable technical data they contain but also because it feels that there is an important problem of policy to be settled and that the engineering profession is better qualified to solve this problem than any other single group. It is an engineering problem and the civil engineer is the one who should devote his closest attention to it.

"THERE are three factors that an engineer during his life's work will be called upon to control, or at least be given an opportunity to do so—material things, living men, and vitalizing policies. Of these, to paraphrase the celebrated dictum of St. Paul, the greatest is policy. The technician can control the first, and sometimes if he is tactful can control part of the second, but it is only the engineer with true professional instinct who can control the first two and initiate the third. He who directs the policy is a fashioner of things and a leader of men."—William Barclay Parsons (1859–1932), Hon. M. Am. Soc. C.E.

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NUMBER 3

Activities of the National Water Resources Committee

BY the middle of the nineteenth century the need for a coordinated plan of water-resources development had already made itself felt in several localities. It was natural that most of these early problems of coordination should have been considered as essentially local in character, and should have been solved in the main by local agreement. Today the situation is completely altered. The conflicts in use of water have multiplied, and the need for something beyond local agreements has become imperative.

An approach to a solution has been made in the past two years by the Water Resources Committee of the National Resources Committee. For purposes of water-resources development, the country has been divided into 17 major drainage basins. In each basin the water resources have been investigated, the principal problems in respect thereof have been clarified, and many potential projects have been examined to determine whether they are compatible with the best interests of the basin as a whole. These projects—more than 7,000 in all—have been divided into classes, by priorities, to provide a basis for a unified approach to the development of our water resources extending over a period of several years.

This work was the subject of the general session at the Annual Meeting of the Society on January 20, 1937, and the following articles are abstracts of papers delivered at that time. Mr. Wolman reviews the recently completed report of the Water Resources Committee, stressing that it represents only the first step in the development of a unified plan. The plan itself can never be crystallized; it must remain plastic, and be subject to continuous remolding. Mr. Fowler describes the drainage basin study in general, calling attention to its limitations and the need for further investigation. Two examples of cooperation between local agencies, states, and federal agencies in working out a unified plan of development are presented by Messrs. Horner and Barrows. In concluding the symposium, Dean Saville points out that one prerequisite for any intelligent plan of water-resources development is adequate hydrological data, and makes several suggestions for improvements in collecting, analyzing, and publishing such information.

Résumé of the Drainage Basin Study Report

By ABEL WOLMAN

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

CHIEF ENGINEER, STATE DEPARTMENT OF HEALTH, BALTIMORE, MD.; CHAIRMAN, WATER RESOURCES COMMITTEE, NATIONAL RESOURCES COMMITTEE, WASHINGTON, D.C.

WHAT should this nation, occupying a vast land of many lands, some wet and others parched, some alternately threatened by devastating floods and by tragic lack of water for crops and stock, do to organize and integrate the use and control of its waters in the best interest of its great population? This, in broad terms, was the task assigned to the Water Resources Committee of the National Resources Committee in the winter of 1936. Specifically, the committee was requested:

1. To determine the principal water problems in the various drainage areas of the country,
2. To outline in broad terms an integrated pattern of water development and control designed to solve those problems, and
3. To present specific construction projects and investigation projects as elements of the integrated pattern or plan, with general priorities of importance and time. The projects were to cover federal, state, and local programs, as currently defined.

The first step in this assignment was accomplished by the committee in the Drainage Basin Study released by the President of the United States on February 3, 1937. This report, of approximately 500 printed pages, sets forth compactly the results of a reconnaissance study of the nation's water problems. A comprehensive and definitive series of answers to the questions involved in the assignment would require a minimum of ten years of detailed field and office study and vastly greater sums of money than have so far been allocated to this important task.

From the regional or national point of view, it may be conservatively stated that water development in general throughout the United States has been haphazard and

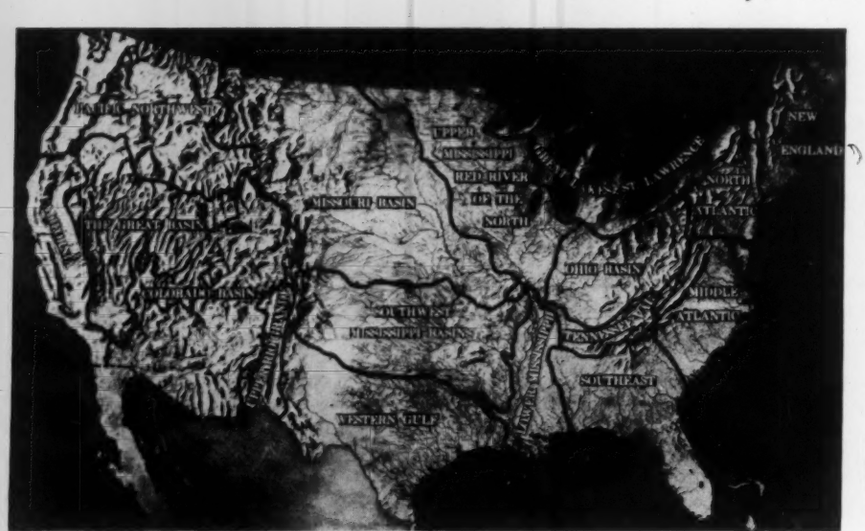


FIG. 1. FOR THE STUDY OF WATER RESOURCES, THE COUNTRY WAS DIVIDED INTO 17 DISTRICTS

Divisions Conform in General with Major Drainage Divisions

without visible plan. During recent years this unintegrated treatment of water problems has begun to disclose the various penalties and defects which careful students of the subject had feared would result. In increasing degree all of us have learned that water is perhaps the most precious natural resource of the nation.

In some parts of the United States the abuse of this resource has already reached the point of dramatic significance. Continued use of water as a planless, orderless procedure would multiply the instances of disadvantage to the public.

A practicable water-development program that could be put into action promptly was a first necessity in each river basin of the country. To disclose whether or not such a program could be formulated and initiated effectively at this time was by no means the least important effort of the Water Resources Committee.

The committee established a special organization, involving as key members a director and 14 regional water consultants, each of whom had immediate responsibility for the conduct of the investigation in one or more drainage basins. On the one hand, the organization worked as closely as practicable with all federal agencies that deal in one way or another with water resources; on the other hand, it cooperated closely with state planning boards, with other state agencies and officials, and with local organizations, utilizing as far as possible the information they provided and profiting greatly from their active assistance.

A SOUND WATER POLICY

A sound water policy, in the opinion of the committee, will have the following characteristics:

1. It will be concerned, in the final analysis, not with water per se, but with the promotion of public safety, public health, public convenience and comfort, the economic welfare of the public, the establishment or maintenance of a high standard of living.

2. It will seek to promote the maximum integrated use and control of water, within the shifting limits imposed by considerations of technical feasibility and of economic and social justification.

3. It normally will treat drainage areas as units with respect to their waters.

4. It will nevertheless scrupulously observe the rights of the several states both in intrastate and interstate streams.

5. It will recognize and abide by the axioms that facts are indispensable prerequisites to sound action, and that conclusions and commitments not based on predetermined facts almost certainly prove indefensible. In keeping with this recognition, it will promote by all feasible means the continuous assembly of the basic data essential for an evolving, unending water plan.

6. It will assign the cost of constructing and operating projects undertaken from time to time as suitable elements in an evolving water plan among the public and private agencies concerned in as close accordance as possible with the distribution of benefits.

7. In determining whether or not water projects are justifiable, and in distributing the cost of meritorious projects among the beneficiaries, it will take properly into account social benefits as well as economic benefits, general benefits as well as special benefits, potential benefits as well as existing benefits, wherever they are involved. Some of these benefits are not capable of exact measurement, but they are subject to reasonable appraisal, and their intangible nature will not justify their neglect in the future. In this particular phase the engineer at large has a contribution to make and an obligation to perform.

TABLE I. DOMINANT REGIONAL WATER PROBLEMS

DISTRICT	DRAINAGE	EROSION	FLOOD CONTROL	IRRIGATION	NAVIGATION	POLLUTION ABATEMENT	WATER POWER	WATER SUPPLY	MALARIA CONTROL	LOW-FLOW REGULATION
New England	..	..	×	..	..	×	..	..	..	..
North Atlantic	..	..	×	..	..	×	..	×	..	..
Middle Atlantic	..	×	..	..	..	×	×	×	×	..
Southeast	..	×	..	..	..	×	..	×	×	..
Tennessee Valley	..	×	×	..	×	..	×	..	..	..
Ohio River	..	..	×	..	×	×	×	..	..	..
Great Lakes–St. Lawrence	..	..	..	..	×	×	×	..	..	..
Upper Mississippi–Red River of the North	..	..	×	..	×	×	×	×	..	×
Missouri	..	×	×	×	..	×	..	..	..	..
Southwest Mississippi	..	×	×	×	..	..	×	..	..	..
Lower Mississippi	×	..	×	..	×	..	..	..	..	..
Upper Rio Grande	..	..	..	×	..	..	..	..	..	..
Western Gulf	..	..	×	×	..	×	..	×	..	..
Colorado River	..	×	×	×	..	..	×	×	..	..
Great Basin	..	..	..	×	..	..	..	..	..	..
California	..	..	..	×	..	..	×	..	..	..
Pacific Northwest	..	..	×	×	..	..	×	..	..	..

For purposes of convenience the country was divided into 17 districts (Fig. 1). At the risk of undue simplification, the dominant water problems of each district are indicated in Table I. It need hardly be pointed out that in each case there are minor problems of other types as well.

SELECTION OF PROJECTS

The investigation emphasized anew the important deficiencies in certain fields directly and indirectly related to water. Almost all of the 127 reports submitted by the consultants stress the urgent need for developing

basic hydrologic data now lacking. The importance of these hydrologic matters cannot be exaggerated, and until existing facilities for normal work in the hydrologic field are increased, progress in dealing with water resources will be retarded more and more as the years pass.

A second tool indispensable for dealing with most water problems, and useful for countless other purposes, is the topographic map. Approximately half the entire area of the country is today entirely unmapped topographically. To correct this deficiency, the committee has recommended the adoption of the suggestions made by the Bureau of Surveys and Maps on October 29, 1934, and now under revision.

Since in many ways the problems of the use and control of water merge imperceptibly into problems concerning the use and protection of land, the planning of water use should not be separated from the planning of land use. For this reason, quantitative studies of the effect of vegetal cover and soil erosion upon hydrologic phenomena, with particular reference to silting of reservoirs and to stream flow, are recommended, at an annual cost of $250,000 for a period of five years. Similarly, an investigation of coastal erosion and the effects of beach-protection works in selected localities is recommended at a total cost of $250,000.

The study of individual projects throughout the United States has also made evident the necessity of regional power-market surveys in order to provide for an orderly and integrated development of streams in particular regions. For the purpose of such surveys, a series of five regional investigations is proposed at a total cost of $625,000.

In the original assignment to the Water Resources Committee, a program of specific projects was requested. Since all the projects in a comprehensive water plan could not be undertaken simultaneously, a program involving priorities became necessary. Such a selection involved obviously the most difficult of the assignments. Among the considerations that must be given weight in determining the order of precedence among projects in any given area are the quantity and reliability of pertinent basic data available; the relationships of benefits and costs; the nature, relative desirability, number, and scope of benefits; relative urgency; the situation with respect to relevant non-technical factors; the relationships to later stages of an evolving water plan; and the present status of the various projects under review.

In general the projects were assigned to one of three classifications:

Group A (immediate)—Projects which are ready for construction or study and which should be undertaken as soon as possible.

Group B (deferred)—Projects which, while desirable for immediate construction or study, (1) involve unsolved questions of public policy, or (2) can have their priority definitely determined only after additional studies which cannot be completed in time for this report, or (3) are now obstructed by legal, administrative, or other difficulties. Group B also includes projects which should follow Group A in sequence of construction or of study.

Group C (indeterminate)—Projects which, although included in the plan of development for the basin, should follow Group B in sequence of construction or whose specific priority in the program is as yet indeterminate.

It must be clear that individual action on, and knowledge of, more than 7,000 projects on the part of each member of the Water Resources Committee was impossible. Dependence had to be placed upon consultants' findings, upon recommendations of state planning boards, upon experiences of state departments of health and other state agencies, upon existing information in various engineering reports, and upon general knowledge of at least the major undertakings.

In many instances, considerations of intangible and imponderable public policy influenced the decision as to classification. In others, theoretical implications had to give way to practical necessities. For example, some projects now under construction perhaps should never have been started; but it is exceedingly doubtful whether it would be practicable to abandon them after 65 to 80 per cent of the physical work has been completed at the cost of many millions, without salvaging at least such parts of the structures as would afford some degree of permanent usefulness. Hence even a poor undertaking into which millions have been poured might well justify completion to recover at least some values.

The problems of water use and control fall approximately into 11 major classes: Bank and coastal erosion control, domestic and industrial water supply, drainage, flood control, generation of electric power, irrigation, navigation, recreation, soil conservation and forest development, waste disposal and pollution abatement, and wild life conservation. These problems may be dealt with separately or in combination. The result has been the inclusion of many projects designed to serve multiple purposes.

The estimated cost of the projects in Group A-1 (investigation projects) is approximately $20,000,000; in Group A-2 (construction projects) $2,327,000,000; and in Group B, $1,424,000,000; making the total for Groups A and B approximately $3,771,000,000.

When it is recalled that in the period from 1920 to 1929, annual federal expenditures for construction involving water use and control ranged from 30 to 63 million dollars, increased to 78 million in 1929, and by 1935 had reached 374 millions, the committee's proposals for a reservoir of projects in Groups A and B for a period of five to ten years, for both federal and non-federal undertakings in the field of water control and use, appear modest and consistent with the normal rate of expenditures for such purposes in this country for many years in the past. The reservoir of undertakings, provided it is followed with continuing review and control in the future, should tend to replace the haphazard approach of the past with a program of orderly development.

Projects of a sanitary nature—water supply and sewage disposal—account for more than half the project costs in Groups A and B. This prominence in position is no doubt accounted for by the great public interest in the problem of sanitation and by the development of a number of projects by interested and efficient state boards of health.

The Group C list aggregated $1,400,000,000. This collection of undertakings needs much more study and evaluation.

COLLATERAL PROBLEMS DISCLOSED BY THE STUDY

A careful reading of the Drainage Basin Report will soon reveal the fact that a number of the problems associated with water use and control have been given therein incomplete consideration, analysis, and conclusion. Such deficiencies are not explained solely by lack of time in the preparation of the document, but also by the great complexity and comprehensiveness of the issues involved. Some of these problems are briefly presented here in order to make clear once more that the present report should be accepted only as the beginning of a highly complicated series of studies which should be continued intensively for many years.

One of the more important phases of water use and control which needs a great deal more study is that dealing with the allied problems of land use. Much more investigation in various parts of the country is necessary in the field of vegetal cover and soil erosion, with particular reference to effects on stream flow. As precise control methods are evaluated, they must find their place in the water program.

Many policies now tacitly accepted in respect of power, flood protection, and reclamation, need renewed analysis and extension. For example, a detailed review of the reclamation policy and problems of the United States is desirable in order to disclose quantitatively what our present situation is in the arid and semi-arid West, what potential lands are open for reclamation, and what effects such extensions of irrigated territory are likely to have upon national and regional economy. That the investigation should be pursued in that direction, as well as in others pointed out herein, cannot be too strongly stressed.

The Drainage Basin Report includes, in the reservoir of proposed projects, undertakings of types that have been financed heretofore by the federal government, those that have been jointly financed by federal and local political subdivisions, and those that have normally been paid for entirely by local groups. The lumping of such undertakings into one group has its dangers. It may give rise to the view that the Water Resources Committee is attempting to extend the sphere of 100 per cent federal financing. Exactly the opposite is the case. Federal, state, and local undertakings have been considered as units of individual drainage basin programs, regardless of sources of funds.

IRRIGATION
The Yakima Federal Reclamation Project, Washington

This was the only basis upon which an integrated water plan could be evolved, but it should not be interpreted as carrying the implication that either local autonomy in, or more important, local responsibility for, financing water projects should disappear from the scene.

Indeed, the committee emphasizes throughout its study the importance of preserving an equitable balance between federal and local payments, commensurate with the incidence of benefits. What the exact yardstick should be for measuring such benefits and payments the committee does not venture to suggest. It does not believe that the broad bases for a definitive national policy on all phases of the problem of financing water projects have been established. It recognizes the urgent need for developing such bases, and has set in motion activities in other directions which it hopes will contribute to their development. At the moment, however, this important and controversial field remains open as an arena for the battle between expanding national interest and declining local responsibility.

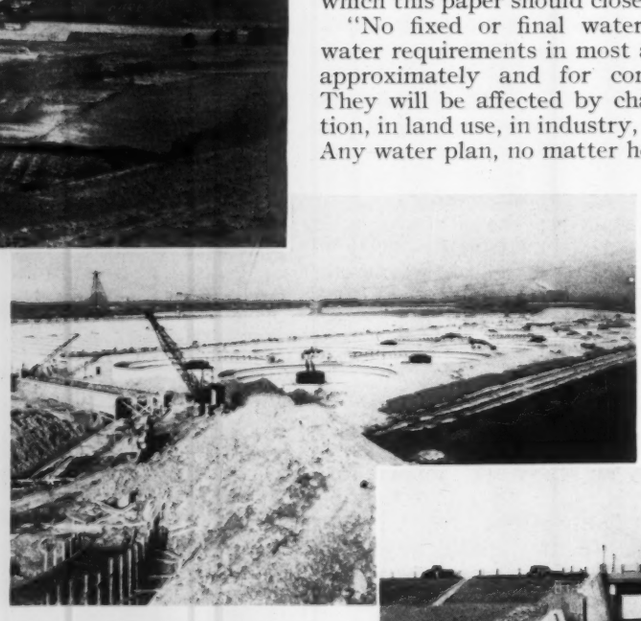
It should be borne in mind that much time and energy, much research in the field of interstate action, of state-federal financing, of regional approach, and of manifold related matters will be necessary before the best way is found to handle many of our water resources problems. As the writer has pointed out elsewhere, slow motion, guided but not controlled by preconception, offers perhaps the least hazardous method of procedure.

SUMMARY

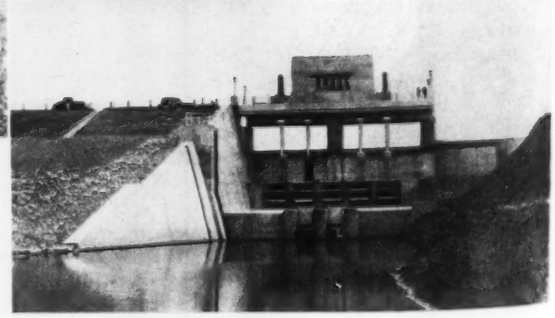
The Drainage Basin Study has importance primarily in focusing attention on water problems from regional and national standpoints. One of its chief purposes is to extend the vision of lay and professional minds beyond the scope of local problems.

The study has been preliminary. It should stimulate thinking in terms of whole basins. That the report has serious limitations in fact and in perspective the Water Resources Committee is certainly aware. The following words from its report are intended to disclose and to emphasize these limitations. They are the keynote upon which this paper should close.

"No fixed or final water plan is possible. Future water requirements in most areas can be estimated only approximately and for comparatively short periods. They will be affected by changes in density of population, in land use, in industry, and in social conditions. . . . Any water plan, no matter how frequently revised, must remain forever incomplete. Continuous planning is necessary . . . . Nevertheless, a framework of a national water plan is proposed that will permit early constructive action on sound lines along a broad front; a plan, moreover, that can be adjusted, filled in, and



SEWAGE DISPOSAL
Aeration and Settling Tanks of Chicago's West Side Treatment Works. This Project Is Scheduled for Completion in December 1938



FLOOD CONTROL
One of the Muskingum Reservoirs, near Massillon, Ohio

extended to meet changing conditions. A beginning has been made; the end can never be reached."

In order to extend the past investigations, particularly in specific drainage basins where critical water problems press for solution, the committee is recommending an appropriation of $2,500,000 to be used to extend information beyond that now available in order to provide bases for interstate action on permanent programs for the use and control of water.

ACKNOWLEDGMENTS

The writer, as chairman of the Water Resources Committee, takes this opportunity of acknowledging the efforts of those who helped to make possible the issuance of the Drainage Basin Study report. The members of the Water Resources Committee are: H. H. Barrows, Department of Geography, University of Chicago; H. H. Bennett, Chief, Soil Conservation Service; Ira N. Gabrielson, Chief, Biological Survey; N. C. Grover, Chief Hydraulic Engineer, U. S. Geological Survey; Edward Hyatt, State Engineer of California; Maj. Gen. Edward M. Markham, Chief of Engineers, U. S. Army; John C. Page, Commissioner, Bureau of Reclamation; Thorndike Saville, Dean, College of Engineering, New York University; R. E. Tarbett, Senior Sanitary Engineer, U. S. Public Health Service; Thomas R. Tate, Chief, Division of Power Resources and Requirements, Federal Power Commission; and Sherman M. Woodward Chief Water Control Planning Engineer, Tennessee Valley Authority.

The regional water consultants, who were responsible for carrying out a very important part of the assignment, were: H. K. Barrows, N. W. Bowden, W. W. Horner, Walter L. Huber, Nathan B. Jacobs, Gerard H. Matthes, Ralph I. Meeker, S. B. Morris, William McKinney Piatt, LeRoy K. Sherman, J. C. Stevens, Royce J. Tipton, Blake Van Leer, and Fred H. Weed.

To the director of the Drainage Basin Study, F. H. Fowler, and the assistant director, M. L. Emerson, the writer is particularly indebted for conscientious effort and continuing good spirit in the completion of a difficult and pressing task. To Gilbert F. White, the secretary of the Water Resources Committee, and to Charles W. Eliot, 2nd, the executive officer of the National Resources Committee, he is deeply indebted for helpful suggestions and broad judgments.

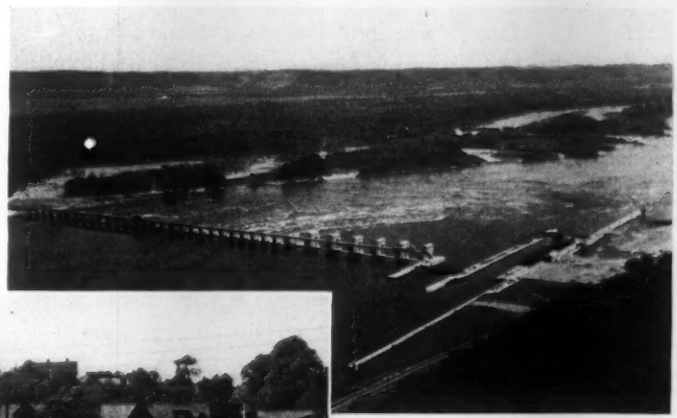
The National Drainage Basin Study

By F. H. FOWLER

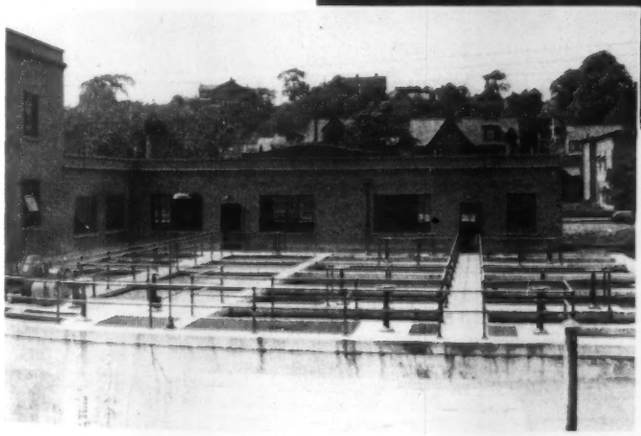
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

CONSULTING CIVIL ENGINEER, SAN FRANCISCO, CALIF.; DIRECTOR, DRAINAGE BASIN STUDY

FROM the outset of its study, in March 1936, the policy of the Water Resources Committee to act only as a coordinating agency was kept clearly in view, and on this policy were based the organizations at Washington and in the field. Both were operated to secure the maximum coordination with existing agencies — federal, state, and local—and the maximum decentralization. Decentralization was secured by division of the country into 17 districts, conforming in general to the major drainage divisions, and the appointment of 17 regional water consultants to conduct the studies in these districts. It was arranged that they should operate through existing federal field agencies, and contact state and local water authorities as far as possible through the various state planning boards. From these state planning boards the consultants received series of reports on the water problems of the various basins within or partially within their respective states. On the basis of these reports and all other pertinent information, the consultants prepared their own reports.



NAVIGATION
Lock and Dam No. 5, on Upper Mississippi River



WATER SUPPLY
Filtration Plant at Tarentum, Pa., to Be Completed in November 1938

The time available was short in comparison with the vast amount of work involved, and the utmost credit is due to the field and to the Washington forces and cooperating agencies for the large amount accomplished. In this accomplishment the Society may take personal pride, since all the regional consultants and a large number of the prominent contributors are members.

The regional consultants, having been chosen on the basis of their accomplishments in their respective fields, were left free to reach their own conclusions on the problems of their districts, with only a general outline of what was required. Their recommendations were submitted

to the Water Resources Committee in the same manner that any consultant reports to a client; their responsibilities ended there.

Upon receipt of the reports in Washington, copies were immediately circulated to the federal agencies represented on the committee or having a vital interest in water matters, in order to secure their criticism, amplification, or approval. Abstracts, in standard condensed form for publication, were then prepared by the Washington administrative forces or by special engineering editors, and submitted together with copies of the consultant's original report to a special editorial committee, composed of members of the Water Resources Committee. The responsibility for further editing or change, and amendment of the project lists, was thereafter assumed by the editorial or main committee. However, its final decisions were not reached until all the consultants had been called (and all but three had proceeded) to Washington, for personal conference. The three who did not report were detained by other duties.

The Water Resources Committee has found that the principal water problems in the various drainage areas of the country are reasonably clear, and outlining a plan of development and control has been reasonably easy. But outlining a system of specific construction projects as elements of a general plan, with priorities of importance and time, has presented special difficulties. This is particularly the case since it necessitated review and appraisal by the committee of thousands of projects, aggregating billions of dollars in cost, and relating to water-resources development during a period of some ten years. Action on certain controversial projects was deferred. Completion of certain projects already constructed in large part was recommended even though their original merit appeared to be gravely in doubt; the committee deemed it impracticable to abandon them now with little or no salvage.

It would be unfortunate if the Drainage Basin Report of 1936 were claimed to be either more or less than it is —an initial or reconnaissance report covering a wide and complex problem. Accepted as such it can well serve as the basis for further study and action. The extent and form of further work will undoubtedly be settled by the present Congress either in its action on federal reorganization, including the oft-proposed Public Works Department, or on the bill for the establishment of a National Resources Committee on a permanent basis. In both these measures the officers and members of this Society have a direct interest. What the outcome will be cannot now be foretold.

In any event the reconnaissance report will have played its part, and any succeeding reports must have more finality. Their production, even if handled by a coordinating agency such as the National Resources Committee, will require an expert personnel, organized on an independent and continuing basis, and availing itself of the most competent consulting services. This should be clear to anyone who considers Mr. Wolman's statement (before the American Water Works Association) that two agencies—the Corps of Engineers and the Bureau of Reclamation—have supervised, in normal times, the greater part of all water projects undertaken by the federal government, and that in the 13-year period preceding 1935 more than 95 per cent of the annual expenditures were allotted to these two organizations. Both these agencies maintain extensive and highly trained engineering organizations, and avail themselves, as occasion requires, of the best consulting services that are available.

Any organization that is to coordinate the work of these and other similar agencies of the government, with the work of non-federal agencies, should be provided with an adequate staff of experts, of at least equal professional skill and experience. Its numbers may be kept to a minimum, but there is an irreducible minimum below which the organization cannot turn out results that will justify its having any part in the program.

The same requirement for a certain minimum personnel holds true for the state planning boards, or for such other state organizations as may handle the work. In some states the planning board or public works department is strongly organized, in others it is either weak or non-existent. A small but well-trained unit in each state is indispensable if the work is to be carried forward. The need for extending aid to such units was fully recognized in the early days of PWA operations and holds true today. It is recognized in the precedent set by the National Resources Committee in furnishing consulting services in the study of the Red River of the North, but will have to be carried further, and into the regular engineering personnel, if satisfactory results are to be secured in the future.

In presenting an annual program for a continuing plan, any coordinating agency must permit adequate time for analysis and consideration by the various agencies whose programs it is seeking to coordinate. Regardless of the care used in preliminary preparation, satisfactory results cannot be reached by hurried final judgment.

To summarize—a reasonable but high-class personnel, an adequate budget, and proper time allowance are prerequisites to the successful continuance of the work, as they are to all other highly technical efforts of similar importance. To face this fact squarely at the outset is an absolute necessity.

Water Plan for the Red River of the North

By W. W. HORNER

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CONSULTING ENGINEER, ST. LOUIS, MO.

DURING five years of drought and critical water shortage, public works proposals in the basin of the Red River of the North (Fig. 1) were concentrated on water conservation and urban water supply improvement. Proposals for the extension of water treatment plants and for sewage treatment received federal assistance, and many of them were carried to completion, but major projects intended to conserve water and bring it to the cities failed of approval—failed in spite of the fact that the Minnesota Economic Council had set up a fund of about a half million dollars as its share of the cost.

Under pressure of critical emergency conditions, the governors of Minnesota, North Dakota, and South Dakota called an interstate conference in Fargo, N.Dak., in July 1935. This conference started as an indignation meeting, but was changed in character by Dr. H. H. Barrows, attending for the National Resources Com-

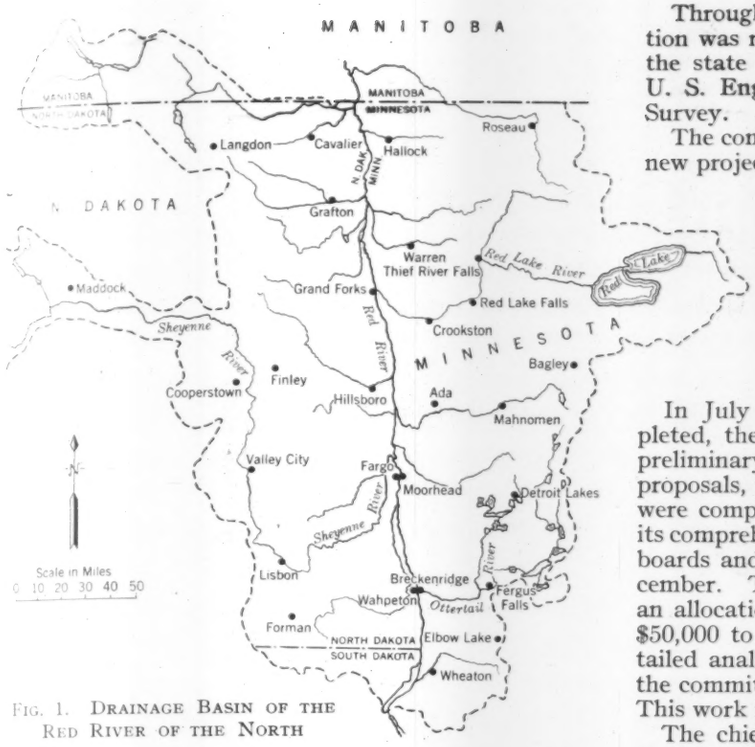


FIG. 1. DRAINAGE BASIN OF THE RED RIVER OF THE NORTH

mittee, who convinced the meeting that the difficulty lay in the inability of the federal agencies to approve, and of the National Resources Committee to recommend, projects that could not be determined to be a part of a properly coordinated water plan. The organization to undertake the studies essential to such a plan was authorized at a second conference, in November 1935, which set up an interstate committee on "Water Plan for the Red River of the North." This committee consisted of the chairmen of the three state planning boards, the consultants of the three state planning boards, and Dr. Barrows and the writer as consultants for the National Resources Committee.

The headquarters of this committee was established in St. Paul, and the work was undertaken through the staffs of the state planning boards. The committee held meetings at least once a month, at which the detailed work for the succeeding month was laid out. These meetings were attended by the many state and local officials who cooperated in the work. Specific studies were undertaken from time to time at the request of the main committee by the State Water Engineers, and the State Sanitary Engineers, who also reviewed and brought up to date basic hydrologic data.

In the spring of 1936, members of the committee, in company with state officials and water engineers, made an extended tour throughout the basin. From place to place they were accompanied by local delegations so that as many as 40 people took part in the inspection in some sections. Meetings were held each evening in one of the important towns, where the problems of the vicinity were presented in detail by local men, and the work of the committee was discussed by one of its members. This not only resulted in giving the committee members a firm, first-hand impression of basic conditions, but had an important educational value throughout the whole area and brought about a sincere and popular appreciation of the work of this particular committee, and of the value of long-range coordinated planning in general.

Throughout the whole course of the study, the cooperation was remarkably effective, not only on the part of the state agencies but of such federal agencies as the U. S. Engineer Department and the U. S. Geological Survey.

The committee was not able to undertake any entirely new project studies, or to draw any final detailed hydrologic conclusions. At one stage of the proceedings it found that it must know rather accurately the probable evaporation losses from certain proposed reservoirs during long drought periods, and for this special work it secured the services of Adolph Meyer, M. Am. Soc. C.E., as an additional consultant to the National Resources Committee.

In July 1936, before its studies were entirely completed, the committee found it necessary to prepare a preliminary report in order to clarify certain project proposals, then critically important. Its general studies were completed during the latter half of the year, and its comprehensive report was filed with the state planning boards and the National Resources Committee in December. The immediate result of its earlier report was an allocation by the Works Progress Administration of $50,000 to the U. S. Engineer Department for the detailed analysis of several important projects, for which the committee had had to qualify its recommendations. This work is now under way.

The chief topographic features of the valley (Fig. 1) are the broad, flat central plain (the bed of old Lake Agassiz), the area of a "thousand lakes" in the glacial moraine country along the eastern border, and the western tributaries emerging from the higher Dakota plains. It should be noted that the larger cities are principally along the Red River itself, the result of early settlement when the river was navigable.

It is today almost impossible to believe that large-size steamboats once operated on this river. Not only is there no flowing water that one would think of in terms of navigation, but in many places there is no evidence of a definite channel of the type that would ordinarily carry a navigable stream. Is it possible that this change is due in any considerable part to the extensive cultivation and drainage of marsh lands?

The normal annual precipitation varies rather uniformly across the basin from 16 in. in the extreme western part to 24 in. in the southeast. An interesting long-range picture of the primary water resources is given in Fig. 2. The steadily decreasing values of annual precipitation and of stream flow are strikingly brought out from a study of 10-year moving averages. Between 1905 and 1930, there was a steady downward trend of annual precipitation values from about 23 in. (average for entire basin) to about 20 in. In the drought years after 1930 the decrease became more marked. During the whole period from 1905 to 1935 the runoff from the basin at Grand Forks showed a similar steady reduction in 10-year averages from about 1.9 in. to about 0.5 in.

This downward trend for the Red River valley is sharper than that for the north central western region as a whole.

The trend in mean annual temperature gives a further index to the shrinkage of usable water resources. The mean value of 39.8 deg for the period of record is equal to the 10-year progressive average for 1905, but from 1905 to 1935 this figure showed a steady increase to 41.6 deg—a rise that must have had a marked effect in increasing the evaporation and transpiration.

With all the larger towns dependent upon stream flow

FIG. 2. PRECIPITATION AND RUNOFF FOR THE RED RIVER BASIN AT GRAND FORKS, N.DAK.

in the Red River and its principal tributaries for their water supply, the flow of these streams during drought years has been reduced to a pitiful trickle and at times has ceased for long periods. (There was no flow at Fargo from June to December 1936.) These streams receive all the urban and industrial wastes, and although a number of sewage treatment plants have been installed, the stream flow has been badly polluted. Actually the available water was re-used several times in its passage through the valley. It was a new and astonishing experience for me to see the cities making safe potable water from the stagnant liquid behind their little detention dams. The water works engineers of this valley deserve the highest praise for having been able to so operate their treatment plants as to produce a fairly palatable water and to avoid serious epidemics.

The major problem of the area is the conservation of flood water and its release and transportation in the stream beds in such manner as to provide a dependable supply at the principal cities. The coordinated water plan was drawn around this central theme. It involved an increase in effective storage in the lakes of the Ottertail River system. These lakes appear to some extent to be exposures of the ground-water table, and by controlling their levels at slightly greater elevations, a largely increased storage of ground water seems possible. The plan provides for a somewhat similar improvement in the use of the Red Lake storage, and for construction of a large dam on the Sheyenne and possibly on other streams on the Dakota side. Small dams are proposed on normally dry streams, for stock watering and rural water-supply purposes.

The plan takes into account not only annual regulation of the streams, but the possibility of a long-time carry-over in storage to meet the needs of drought years. Particular consideration is given to the stabilization of lake levels, in order not to disturb unduly their high recreational value.

An important phase of the plan is the improvement of the channels for the purpose of reducing losses in transit. Such losses are at present extremely high in the basin; flows of as much as 30 cu ft per sec in the Ottertail River, for example, may be dispersed before reaching Fargo.

While the disastrous floods of 1916–1919 have been nearly forgotten, the committee is convinced of the probability of their recurrence, and its plan contains provision for flood-flow correction. It also gives consideration to the improvement in power possibilities that will result from the regulation of stream flow.

The report recognizes the interstate character of the basin problems and the necessity for a carefully worked out and unified program of operation. It includes a scheme for an interstate authority with power to control the water resources and to levy limited assessments on the beneficiaries. The attorneys general of the three states have prepared enabling acts, which are expected to receive favorable action during the 1937 sessions of the legislatures. As the execution of the plan should result in the reduction of flood flows, and the augmentation of low flows at the Canadian border, it should not arouse any controversial international questions.

The plan is programmed in three classes of immediate, deferred, and indeterminate construction, involving successive periods of about three, two, and five years. The projects in each class may be grouped roughly as to purpose as follows:

Purpose	Group I	Group II	Group III
Water conservation	$1,900,000	$ 650,000	$ 440,000
Transportation of water	1,200,000	40,000	0
Water works and sanitation	5,400,000	0	700,000
Flood flow correction	1,200,000	2,550,000	1,000,000
Totals	$9,700,000	$3,240,000	$2,140,000

This grouping is of course rather arbitrary, as many of the projects serve more than one purpose and quite a number of them have important value for recreation and for wild-life conservation.

The Rio Grande Joint Investigation

By HARLAN H. BARROWS

CHAIRMAN OF THE DEPARTMENT OF GEOGRAPHY, UNIVERSITY OF CHICAGO, CHICAGO, ILL.

CONTROL of inland waters rests in large part with the individual states. However, critical water problems are presented throughout the country by streams that cross or border several states, each of which naturally has been disposed to apply the doctrine of "rugged individualism" when its interests have conflicted with those of its neighbors.

Controversies between states over rivers multiply as the varied requirements for water increasingly tax the limited supply. Experience has shown that litigation is a slow and costly method of settlement, and that the results are likely to be inconclusive and unsatisfactory to the public. If a stream is long and large, and particularly if it drains areas dissimilar in surface and climate, it is practically impossible to present before any court all the facts and considerations essential to an equitable and workable solution.

The only alternative to litigation, at least in the absence of effective federal control over interstate streams, is some form of voluntary interstate agreement. Unless this method proves successful there doubtless will develop sooner or later an irresistible demand that the federal government be given complete control of all interstate streams. The compact method is on trial.

The Rio Grande Joint Investigation constitutes a unique approach to the underlying problems of a grave

controversy over an interstate river. It is no fault of any of the states of the Rio Grande basin that a plan of development, restricting each state to an equitable share of the water, and perhaps limiting irrigation to the better lands, was not worked out years ago; nevertheless, without such a plan a serious conflict of interest was inevitable.

A special board of review appointed by the National Resources Committee in the summer of 1935 at the suggestion of the Bureau of Reclamation found that a situation existed in the upper basin which was inimical to both public and private interests, that apparently the available water resources were fully appropriated, and that federal funds were being sought for new projects which not only might create conflicts among existing federal projects, but also would violate an existing temporary compact, which provides in essence that further depletions of the waters of the Rio Grande shall not be made before June 1, 1937.

Shortly after this review, the President issued an executive order instructing appropriate federal officials not to approve any application for a project involving the use of Rio Grande waters without securing from the National Resources Committee an opinion on it from all relevant points of view. In December 1935 the Rio Grande Compact Commission requested the National Resources Committee, through its Water Resources Committee, to arrange immediately for a cooperative fact-finding investigation. This was to cover the water resources of the Rio Grande basin above Fort Quitman (in western Texas); the past, present, and prospective use and consumption of water in that basin in the United States; and the opportunities for conserving and augmenting such resources. The commission recognized that actual facts are prerequisites to the successful negotiation of a permanent compact, and that these facts should be determined by an impartial organization.

The National Resources Committee accepted the responsibility of guiding the investigation; the requisite funds, aggregating more than $375,000, were provided through federal and state contributions; and complete plans were promptly agreed upon by representatives of the federal, state, and local agencies concerned with the undertaking. The basic field work is being completed, and the findings will be available in April 1937.

Most of the field work is being done by three federal bureaus. The U. S. Geological Survey is investigating stream flow at all essential points on the main river and its tributaries, all the diversions and return flows of water, the underground waters, and in cooperation with the Bureau of Plant Industry, the chemical quality of the water. The Bureau of Agricultural Engineering is dealing with the problems of consumptive use of water, the vegetative cover on all irrigated lands and water-consuming areas, and the water requirements of irrigable lands. The Bureau of Reclamation is making surveys of the possibilities for storage and for importation of water by transmountain diversion. In addition, the Soil Conservation Service, the Resettlement Administration, the Bureau of Indian Affairs, and various other federal, state, and local agencies are providing services, materials, records, office and laboratory space, and the like.

The participating agencies have cooperated superbly, and the field organization has worked enthusiastically, apparently sensing in the enterprise a great opportunity and a great challenge. In accordance with the wishes of the compact commissioners, no construction projects in the upper valley have been recommended in the drainage basin study described in Mr. Wolman's paper. They wisely decided that such recommendations should await completion of the joint investigation.

At this stage, it seems reasonable to believe that the investigation will provide a sound basis for a satisfactory apportionment of the waters of the river; for a plan by which the water that may be made available by salvage, storage, importation, and other means will render full service; and for a program looking to construction of the requisite works in an orderly, balanced manner.

But a firm foundation marks only the beginning of an edifice, and any edifice will in time need repairs and alterations. In the upper Rio Grande basin, as elsewhere, continuous planning will be necessary. All factors that may possibly be relevant, whether economic, social, or physical in character, must be analyzed, correlated, and synthesized in order to ensure wise recommendations.

Many of these factors lie beyond the scope of engineering. Their analysis calls for the cooperative services of experts in other fields. It is only necessary to refer to the question of economic justification for a ship canal or for a system of flood-control works to illustrate this point concretely.

The President's Committee on Administrative Management inadvertently stated, in a report issued a short time ago that "a complete water plan for the United States has been prepared." Obviously, such is not the case. As Mr. Wolman indicates, quoting from the Drainage Basin Report itself, "a beginning has been made; the end can never be reached." Those of us engaged most actively in the work hope that their modest beginning may meet with approval, and that we may count upon the invaluable aid of the American Society of Civil Engineers in carrying the work forward.

Collecting and Publishing Hydrologic Data

By THORNDIKE SAVILLE

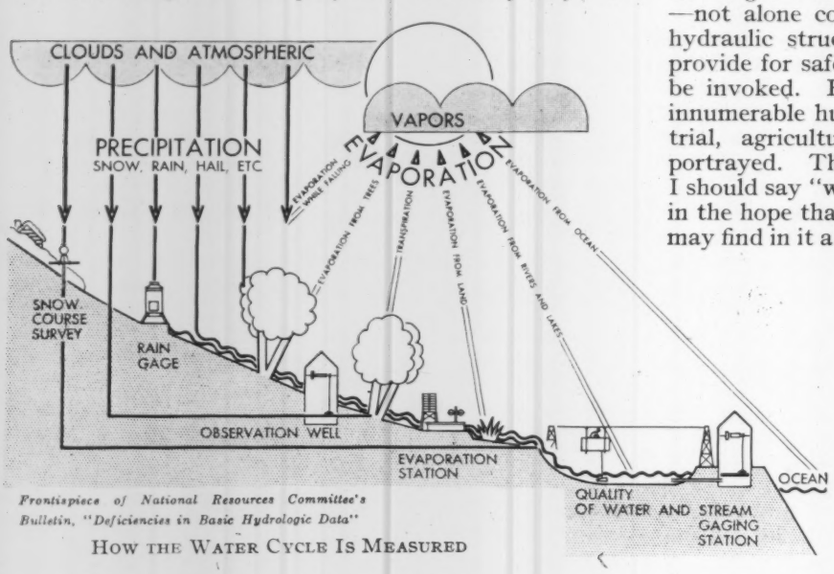
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

DEAN, COLLEGE OF ENGINEERING, NEW YORK UNIVERSITY; MEMBER, WATER RESOURCES COMMITTEE OF NATIONAL RESOURCES COMMITTEE

ONE of the fundamental laws of physical science is that inanimate nature, if left to herself, moves in the direction of chaos." When Dr. Karl T. Compton thus paraphrased the second law of thermodynamics, he was not referring to water or to land. He went on to point out that with respect to physical science there is only one way yet suggested to circumvent this tendency toward chaos—the exercise of intelligence in carrying out a planned policy. These statements apply with equal force to the science of hydrology, which deals with water in all its manifestations, in the atmosphere, over the surface of the land, and underground.

Not only does water of itself tend toward chaos in its effects upon the works of man, but the increasing complexity of man's life in this present civilization has tended more and more to produce chaotic thinking as to pro-

cedures for the most effective control and utilization of our water resources. Order cannot be brought out of this chaos, either in physical nature or in man's thinking, within the biblical period of six days. As Dr. Compton points out, planning is the only expedient that will serve. Technical design of water projects is relatively easy; the difficult task is to plan a method of attack on conflicting water problems to produce a logical and economically sound synthesis of physical plans.



Frontispiece of National Resources Committee's Bulletin, "Deficiencies in Basic Hydrologic Data"

HOW THE WATER CYCLE IS MEASURED

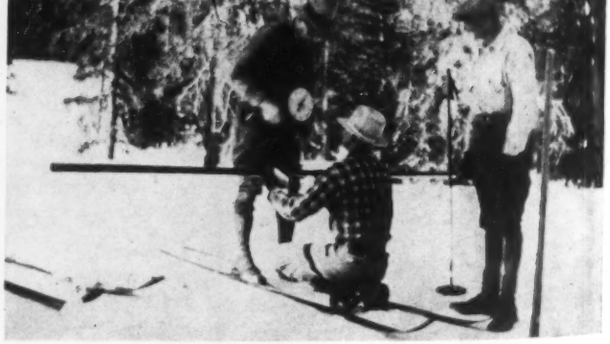
In every attempt to plan for the orderly and coordinated development of water resources, there is one requirement that is never satisfied—the securing of adequate factual data relating to precipitation, streamflow, ground water, evaporation, transpiration, infiltration, chemical and physical quality of the waters, and so forth. A number of federal and state agencies have been collecting and publishing basic hydrologic data for many years. Yet the information available to designing and operating engineers is not enough in quantity, is not adequately distributed throughout the country, is sometimes not in the best form or collected under suitably accurate conditions, or is not easily accessible. To take stock of the basic collecting and publishing activities of the numerous federal agencies, the Water Resources Committee appointed a special advisory committee on hydrologic data which, in the opinion of the writer, has demonstrated admirably how the activities of governmental agencies may be stimulated, improved, and coordinated in practical fashion.

This advisory committee consisted of the responsible officers of three of the principal data-collecting federal agencies, four eminent hydrologists and hydraulic engineers not in government service, and a non-government member of the Water Resources Committee as chairman. All but one of these men are Members of the Society. The committee undertook first to set forth standards for the collection and publication of basic hydrologic data, and to allocate to specific agencies responsibility for the collection or publication of specific types of data. This in itself was a considerable task of coordination, involving changes in established practice and a general give and take. Next the committee undertook to appraise the basic data-collecting programs of all federal agencies, to determine whether they were adequate, and if not, where expansion was justifiable, and what it would cost.

The result of this work is summarized in the report issued in June 1936, entitled "Deficiencies in Basic Hydrologic Data." This report presents for the first time a carefully considered, well-integrated, balanced program for the collection and publication of basic hydrologic data on a national scale. It calls attention to the great cost of ignorance of simple hydrologic facts—not alone costs due to failure from under-design of hydraulic structures, but costs due to over-design to provide for safety where a "factor of ignorance" had to be invoked. Both the tangible and intangible loss to innumerable human activities of an engineering, industrial, agricultural, and social character are vividly portrayed. The document, dealing with dry (perhaps I should say "wet") facts, is made as readable as possible in the hope that engineers, knowing the needs described, may find in it a dramatic presentation which may be used effectively before layman and politician alike.

In the light of the principles set forth in the report, the committee made the following recommendations:

1. Precipitation data should be made more effective by the inspection and rehabilitation of existing precipitation stations; by the publication of hitherto unpublished precipitation records; by the establishment of 1,200 new cooperative rainfall stations in localities where rainfall is not now measured; by the establishment of 6 new first-order meteorological stations at high altitudes; and especially by the establishment of 400 recording gages to collect data on intensity of rainfall, properly distributed as to area so as to average one to every 5,000 sq miles.
2. Forecasts of stream flow above important irrigation, navigation, flood-control, and power projects should be improved by the establishment of at least 500 snow-survey courses in mountain areas. Federal interests are largely involved.
3. Stream-flow data should be improved and extended by the establishment of 500 base stream-gaging stations, and 600 cooperative secondary stations, and by the rehabilitation of 1,000 old stations.
4. Information concerning the amount, position, and fluctuation of ground water throughout the United States should be expanded by the installation of 4,000 wells as base stations; by the installation of 6,000 cooperative secondary wells (1,000 of them to be discontinued and replaced by new wells annually); and by



Bureau of Agricultural Engineering

A SNOW-SURVEY PARTY, MEASURING DEPTH AND WATER CONTENT OF SNOW IN THE HIGH SIERRAS

carrying on corollary geologic and hydrologic investigations.

5. Evaporation data should be improved by the establishment of 30 first-class stations and 250 second-class stations; by the compilation of unpublished data; and by the prosecution of research on the solar-energy method of determining evaporation, and on evaporation from surfaces of snow and ice.

6. Data on the quality of surface water should be collected systematically by a network of 200 base stations and 400 cooperative secondary stations for analysis of mineral content, acidity, oxygen content, and silt load. At 100 of the base stations pollution measurements should also be made.

7. For efficiency it is desirable not only that the data-collecting program be enlarged as here recommended, but that a careful review of existing installations be made, with the object of abandoning or relocating stations that do not fit into an orderly and systematic program.

The committee has distinguished clearly between work which should be carried on by the federal government alone, in order to secure continuous records at strategically located base stations, and that which should be contingent upon equal contributions by federal and local or state agencies. It has indicated the federal agencies that should be responsible for the recommended work in each case, and has recommended procedures for publishing data.

In Table I is shown the total cost of the program for correcting the glaring deficiencies in our knowledge of water resources. The committee believes that an expenditure of $2,906,250 for the first year and $1,429,500 for each successive year would be a moderate investment of federal funds for so urgent a need. It believes that state and local agencies will support their part of the program, at a cost of $770,250 for the first year and $394,500 for succeeding years.

There is every reason to suppose that these small expenditures, systematically and scientifically made, would save the country many millions of dollars and perhaps many human lives during the coming generation.

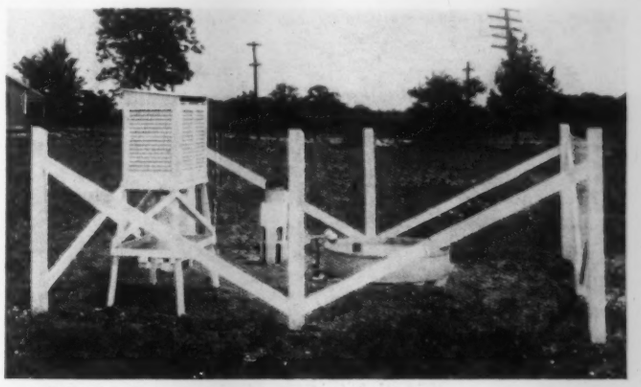
Hundreds of millions, probably billions of dollars will be expended upon the development and control of our water resources within the next two decades. The expenditure of perhaps $3,000,000 a year to obtain accurate and adequate data, by which alone these projects can be safely and economically designed and operated, is small insurance. It is so small, it is so undramatic in its implications, that the layman finds difficulty in viewing it as something that really affects his life and his pocketbook; and Congress, responsive to popular demand, finds little impetus to add a million dollars a year scattered through a number of bureaucratic agencies. To cut down these vital services is an easy way to "balance the regular budget."

TABLE I. SUMMARY OF COST OF PROGRAMS RECOMMENDED TO CORRECT DEFICIENCIES IN BASIC HYDROLOGIC DATA

CLASS OF DATA	COST					
	First Year			Succeeding Years		
	Federal	Non-Federal	Total	Federal	Non-Federal	Total
1. Precipitation	$ 396,000	.....	$ 396,000	$ 223,000	.....	$ 223,000
2. Snow surveys	169,000	$ 39,000	208,000	58,000	12,000	70,000
3. Stream flow	1,450,000	450,000	1,900,000	370,000	120,000	490,000
4. Ground-water levels*	406,250	131,250	537,500	312,500	112,500	425,000
5. Evaporation	35,000	.....	35,000	16,000	.....	16,000
6. Water quality	450,000	150,000	600,000	450,000	150,000	600,000
Totals	$2,906,250	$770,250	$3,676,500	$1,429,500	$394,500	$1,824,000

* The second-year cost of measurements of ground-water levels is intermediate between first-year and succeeding-year costs.

It is to the engineer, and particularly to the civil engineer, that the public and Congress should look for guidance in measures of this sort. Not only this report on "Deficiencies in Hydrologic Data," which is summarized in the Drainage Basin Study described by Mr. Wolman, but indeed all the activities of the Water Resources Committee are peculiarly the work of members of this Society. It would seem no more than appropriate that this Society, through its Local Sections particularly, should consider and discuss these reports, and then bring appropriate pressure to bear upon Congress and upon the states to carry out such programs and procedures relating to water as the civil engineering profession may endorse.



U. S. Weather Bureau

STATION FOR OBSERVING EVAPORATION FROM WATER SURFACES
Complete with Thermometers, Rain Gage, Anemometer, and Evaporation Pan

The Water Resources Committee is unique in that it has been composed of both government and non-government engineers, has been responsible to no single bureau of the government, and has consistently rejected every opportunity to undertake executive functions rather than investigatory and coordinating ones. It is unique too in that it has performed its work with virtually no permanent staff, but has employed expert consultants particularly qualified for each new task that has come to it.

Successfully to attack the extremely complicated problem of water resources development requires a far more comprehensive and scientific program than has thus far been formulated. The technical and legal difficulties are serious but not insurmountable. It should be evident that during the past three years there has been increasing public response to thoughtful promotion of water resources study. Surely it is not vain to predict that in the next few years what Dr. Hans Zinsser calls that "curious lag between the acceptance of high principles and the application of such understanding to practical purposes" may be overcome, and recognized principles may be applied successfully by the engineer and his associates in the field of water resources to promote the comfort, convenience, and welfare of mankind.

Some Recent Highway Developments

Progress Noted in State-Wide Planning, Estimating Financial Returns, and Roadside Improvement

ADDRESSES on three recent developments in the highway field were made on January 21, 1937, at the Annual Meeting of the Society. Abstracts of these papers follow. The first two papers, dealing with planning for highway systems on a state-wide basis and methods for estimating financial returns from a typical new major artery, were delivered before the Highway Division. The third, presented at a session of the City Planning Division, emphasizes the importance of rural zoning in roadside improvement.

In the first paper, Mr. Fairbank points out that the expansion of good roads in America has been in part unsound and uncoordinated, because factual data for better planning were not available. But now a better type of planning is in view, and already forty states have undertaken to cooperate with the U. S. Bureau of Public Roads in extensive planning surveys, largely with the aid of federal funds. The surveys include an inventory of road details and structures, a study of traffic as to character and flow, weight and commodity surveys, financial compilations, and studies of road life.

The second paper of the symposium, by Mr. Downer, deals with one of the latest additions to New York City's highway facilities—the Henry Hudson Parkway, opened in December 1936. Starting near the north end of Manhattan Island, it provides an outlet for Riverside Drive to the north, connecting with the parkway system of Westchester County. Favorable income figures for the first month of operation lead him to conclude that the project will easily carry its interest load and will also increase traffic on connecting parkways.

Various ways for improving roadsides are discussed by Mr. Carmalt. The best and most important of these is control of the countryside through which the highway passes, to be effected by broad zoning regulations restricting the use of land. This rural zoning is usually much simpler than that for cities, and local plans may be developed simultaneously with general or regional ones.

State-Wide Highway Planning Surveys

By H. S. FAIRBANK

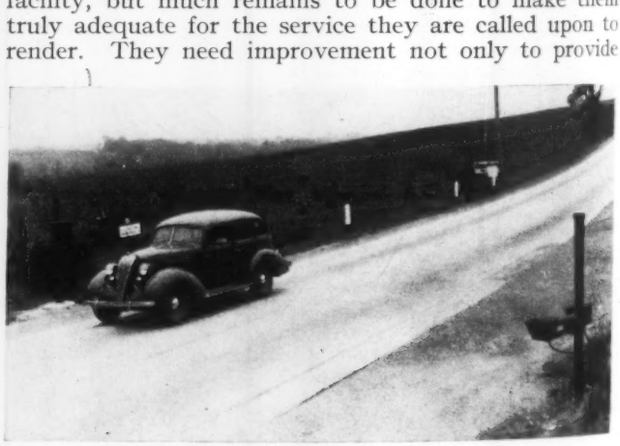
CHIEF, DIVISION OF INFORMATION, U. S. BUREAU OF PUBLIC ROADS, WASHINGTON, D.C.

IN the summer of 1935 the U. S. Bureau of Public Roads laid before all state highway departments a proposal that they join with it in a series of related fact-finding studies designed to develop information needed for a sound program of future highway improvement. The Bureau also proposed that advantage be taken of a recent provision which would permit the larger part of the cost of the studies to be met with federal funds. Several states responded favorably at once, and in November 1935 the first work was begun in Pennsylvania, followed quickly within a year by cooperation in 40 states.

In proposing the studies, the Bureau recognized that in improving our roads we have reached the end of a pioneer period and that policies and attitudes adapted to former needs would require modification to fit them to the altered conditions of the new stage. It was to develop the essential information and to draw a clearer picture of further improvement needs that the studies were mainly designed. A secondary motive is to replace with indubitable facts the mass of conflicting opinion and biased report used at present in the taxation and regulation of highway vehicles and traffic, and in the coordination of highway transport with other forms of transportation.

RURAL ROADS IN TWO CLASSES

Until recently rural roads have been treated in two distinct categories for purposes of administration and improvement. In the one group there has been a gradually increased mileage, now approximating 330,000, constituting the state and federal-aid systems of main intercity highways. This has been improved under the state highway departments, in part alone but often jointly with the Bureau of Public Roads, and financed with state and federal funds. These main highways vary in proportion to the whole rural road mileage from state to state, ranging from about 5 to 40 per cent. According to rough approximations, they serve from 50 to 70 per cent of the whole rural highway traffic, measured in vehicle-miles. These roads as a result of methods designed to hasten their improvement as a continuous system, now permit travel to all parts of the country with reasonable facility, but much remains to be done to make them truly adequate for the service they are called upon to render. They need improvement not only to provide



AN AUTOMATIC, ELECTRIC-EYE TRAFFIC RECORDER

Invisible Beams from Twin Lights at Right Are Focused on Electric Cell of Counting Mechanism Opposite. Pedestrians, Intercepting Only One Beam at a Time, Are Not Recorded

further refinement, deliberately deferred in favor of more essential fundamental improvements over the whole system, but also to meet the progressive demands of traffic, especially the recent marked changes in the speeds of automobiles.

In the second of the two principal groups has remained the far larger part of the rural mileage, roughly estimated at 2,700,000. This group, made up mainly of roads inferior in traffic importance to the first, and affording local service, has been improved to varying degrees under thousands of local governing authorities. Serving in the aggregate roughly 40 per cent of the total rural vehicle-mileage, these roads include some sections that probably compare favorably in importance with parts of the main system and, at the other extreme, thousands of miles on which the daily traffic can be tallied on the fingers of one hand.

Because of the chaotic state of local government records, it is little better than a guess that approximately a third of the total mileage has been improved to some degree. But to what extent the improvement is satisfactory, and how much further improvement is needed are questions that have been wholly beyond the possibility of reasonable answer.

GROWING TAX DIVERSIONS

From the beginning it has been the policy to improve main highways through motor-vehicle license fees and gasoline taxes and all federal highway appropriations. An assured and increasing revenue from these sources has made possible an orderly improvement. Real property taxes, at first furnishing considerable revenue, have been progressively withdrawn and are now unimportant.

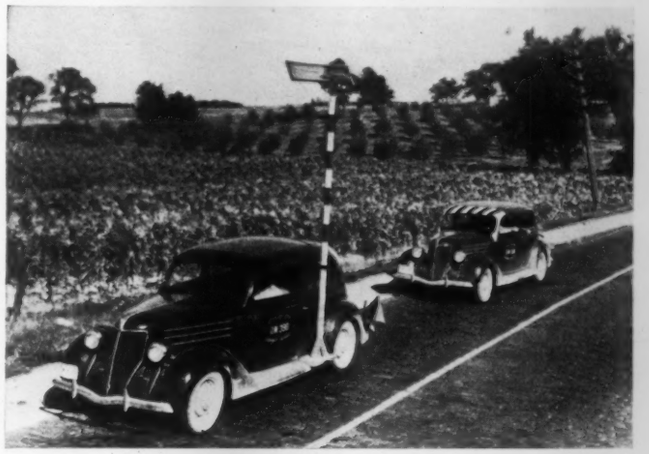
For the local roads, property taxes have always, until lately, furnished the greater part of the revenue required; but as time has gone on motor-vehicle and gasoline taxes have been slowly but steadily transferred, in increasing amounts, for their improvement. And in recent years, by abrupt and in most instances ill-considered action, the whole burden of local as well as main road improvement in several states has been shifted to the shoulders of the motor-vehicle owner and gasoline taxpayer. Also, there has been a similarly gradual increase in those revenues allotted for city street purposes.

These tendencies reached a climax during the depression, with the widespread abandonment of the effort to raise property taxes for road purposes and the aim to devert motor-vehicle and gasoline revenues to various purposes foreign to road improvement. This tendency was halted by the penalty provisions in the Hayden-Cartwright Act of 1934, but not before the diversions had imperiled the continuance of even the most essential highway operations. The situation was relieved—in some states in the nick of time—by the increase in federal highway appropriations designed to promote employment during the emergency.

What might have been a major catastrophe was thus temporarily averted, but as many of the causes that tended to precipitate it remain, there is still occasion for grave concern as to the future support of the highway program.

SAFETY AND ECONOMICS ARE PRIME OBJECTIVES

Although not generally realized, it should be apparent that the first obligation payable from future highway funds is the maintenance and further improvement of the more important highways. Such roads urgently need further improvement. Recent increases in speeds require a general easing of existing sharp curvature and a general lengthening of present restricted sight distances. Surfaces of low type, intended for temporary service, must be raised to their ultimate standards. There is widespread need for more liberal width on two-lane roads, for pavements providing more than two lanes, and for the correction of devious alignment and indirect routing. These will necessarily involve expendi-



TWO CARS ARE USED TO MEASURE SIGHT DISTANCES
All Those Less Than 1,000 Ft on Main Highways Are Recorded

tures far beyond past outlays, especially in view of the greater widths now considered essential. Other probable needs are for a limited mileage of express highways, for a program of railroad grade-crossing elimination, and for separation of grades at intersections of important highways.

These needs are expressed in most cases in the undeniable terms of safety and prime economic and social benefit. They constitute therefore, with maintenance of the existing capital investment, a first draft on future available revenues, and must be so treated. But though the need is recognized in general, there is nowhere such an exact knowledge of the particular requirements as will be necessary for a prudent reservation of covering revenues. Such an itemization of the further needs of the main highways is one of the principal objects of the planning surveys.

Other purposes are: First, to determine, by such objective tests as may be feasible, the relative economic and social services performed by all parts of the large mileage of roads not included in the present main highway system; and then to determine how much of the more important parts of this mileage it will be possible to improve, and to maintain as well, within the limits of the funds likely to be available after deduction of the amounts essential for the support of main highways.

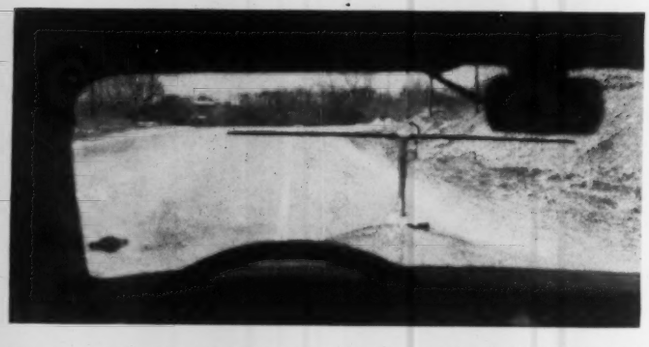
Observe that emphasis is placed upon a proper provision for the maintenance of what is built. This includes also the renewal of road plant as depreciation and obsolescence require. Unless this future obligation is provided for, we may find eventually that we have created a larger investment than we can comfortably maintain. In determining how far it is wise to go in improving additional mileage of local roads, we must set off against future revenues the whole annual cost of the improved mileage, in which the costs of future maintenance and renewal must be included.

In their bearing upon the problems of the lesser roads, the planning surveys are designed to reveal not only the relative importance of the roads and the true cost of their improvement, not only the mileage that can be improved within the limits of funds probably available, but also their future administrative control, and especially

the sources from which the revenues necessary for their construction and maintenance may fairly be drawn, with due consideration of the benefits they afford.

SOME QUESTIONS TO BE ANSWERED

The tendency to transfer a larger part of the cost of highways to those who, as users, benefit most directly



SHOWING METHOD OF DETERMINING WHEN THE SIGHT DISTANCE IS LESS THAN 1,000 FT

Rear Car Keeps Approximately 1,000 Ft Behind Front One by Watching Interception of Horizontal Sighting Bar on the Stadia Rod Carried by Forward Car. When Occupants of Cars So Spaced Lose Sight of Each Other, They Have Found a Sight Distance That Must Be Measured

from them, raises important questions as to the additional amount that may be extracted from such users as a body and, particularly, as to the relative amounts of the whole road-user contribution that should be paid by passenger automobiles and by trucks and busses. At present there is a lack of acceptable basic information concerning the actual characteristics of the various classes of vehicles in relation to highway demand.

Nominal capacity classifications of motor trucks by manufacturers give no clue to the loads actually carried. But what are these actual loads? Gross loads of vehicles do not determine the design or the cost of the highway structures; wheel loads are the determining factors. But what are the customary maximum wheel loads of separable classes of vehicles? The mileage of roads that must be designed for use by heavy vehicles and the consequent effect of such heavy vehicles upon the total highway cost depends upon the actual range of operation of such vehicles. What roads are they likely to use in sufficient numbers to require an improvement consistent with such use? The surveys will supply the factual answers.

The existing hodgepodge of laws regulating the use of the highways is commonly deplored. Generally, there is lip service to the need of uniformity as between states. Among the studies included in the planning surveys there is definite provision to supply these needed facts with certainty and beyond controversial refutation.

BEGINNING WITH AN INVENTORY

As a precise knowledge of the present extent and condition of the whole highway system is the first essential to further effort in highway improvement, so an inventory is the first phase of the planning surveys. The inventory is taken by driving over every mile of the rural road system as it exists on the ground. By odometer measurement the length of each section is determined, and a record is made of all the other details of the road and its structures.

On the main roads, where safe service of high-speed traffic is an imperative objective, the existing curvature and sight distances are being tested according to standards chosen as the minima essential for the service of definite maximum speeds, assumed to be 60 miles an hour in non-mountainous areas and 40 miles an hour in mountains. Reasoning that 6 deg is the limit of curvature safe for travel at 60 miles an hour in the presence of a maximum practicable superelevation of $1^1/_4$ in. per ft, all curves on the main highways in non-mountainous territory that exceed this limit are being located and measured. In mountainous terrain, with a 40-mile speed as the criterion, there is similar location and measurement of curvature on the main highways exceeding 14 deg.

With the same speeds in view, the inventory of the main highways also includes the location and measurement of all sight distances that, for any reason, are less than 1,000 ft in non-mountainous sections and 650 ft in the mountains. Also, on the main highways, where heavy trucks and trailers of relatively low hill-climbing ability are to be expected, all grades longer than 500 ft are being measured and recorded—in non-mountainous areas if they exceed 5 per cent, and in mountains if they exceed 8 per cent.

At level crossings of railroads all existing physical conditions are being exactly recorded. To these data there is to be added later a record of the highway traffic over each crossing, and with the aid of the railroads, a record of rail traffic and accidents. When all these facts are available for every crossing, it should be possible, as it has not been heretofore, to measure the dimensions of the grade-crossing problem and to establish an order of priority in grade-crossing elimination.

Such an inventory, which also includes exact information concerning the distribution of homes and business places in rural areas, should be invaluable to future highway and other public planning.

THEN TRAFFIC STUDIES

As the second major department of the surveys, there will be a variety of studies of the character and flow of traffic, of the kind generally included in traffic surveys

A WEIGHT STATION ON OHIO ROUTE 31

Portable Scales Are Used for Trucks and Busses

but extended for the first time beyond the main highways and covering the whole rural road system. The first use of these studies will be to establish the present relative traffic importance of all rural roads. On the basis of such information it will be possible for the first time to determine what selected sections of the road system serve any given percentage of the whole traffic movement, measured in vehicle-miles.

Origin-and-destination studies of one type will provide the data necessary for the solution of recognized problems of highway relocation. Another type will bring out clearly such differences as there may be in the character of use of the main highways and the local roads. It is generally supposed that main highways serve a far-ranging traffic, which in considerable part spans state lines and constitutes a through movement between cities. It is also assumed that traffic on the lesser roads is of more local origin and service. The origin-and-destination studies will establish the true conditions, whatever they may be.

The purpose of these determinations lies in the necessity of making a fair distribution of the cost of highways between urban and rural taxpayers and between road user and property-taxpayer—an object of such importance, and yet so elusive, that it is considered necessary to approach it by another type of investigation, called the road-use study. This is classed generally with the financial group, constituting the third major department of the surveys.

A SURVEY RECORDER QUESTIONS A TRUCK DRIVER AS TO HIS ORIGIN, DESTINATION, AND OTHER MATTERS

Two weight and commodity inquiries are also under way. One, conducted at many points on the main system with portable scales, and on the local roads by methods of estimation, seeks to determine the range of vehicles of the various weight groups over the whole road system, with the double object of supplying information essential for road-surface and subgrade design and determining the relative responsibility of the several vehicle groups for the repayment of road costs. The second study is conducted generally at a few permanent pit-scales, and is intended to fix with accuracy the true characteristics of various classes of vehicles. In both, account is taken of the commodities transported, for consideration in connection with weights and recorded lengths of haul in future efforts to promote a better coordination of all transportation facilities.

FINANCIAL STUDIES HAVE DIRECT APPLICATION

The financial studies, although the last to be mentioned, are likely to be the first resorted to in the program-planning effort for which the present surveys are designed to supply the basis. Their first purpose is to determine the full magnitude of the present financial provision for road and street purposes, and to reveal the existing relation between the sum of all highway revenues and expenditures and the grand total of all revenues of the states and their subdivisions for all purposes of government and public service. The next object is to classify revenues according to source, and expenditures according to object, and then to discover the incidence of the revenues, as payable by various taxpaying groups, and the shares of the same groups in the benefits resulting from the expenditures.

The relation found to exist will serve to indicate whether, and to what extent, it will be possible in the future to count upon a higher rate of taxation and expenditure for highway purposes; whether the tax burden is equitably distributed at present, and if not, what changes are needed to effect a juster balance. Special studies will ascertain how nearly the present rates approach the point of diminishing returns from all forms of taxes. By such studies as these it is hoped to indicate the probable maximum financial support that will be available for highways in the future and the taxing measures that will most equitably distribute the burden of such support.

And finally, by means of what are called road-life studies, an effort is being made to determine the economic life expectancy of various parts of the highway structure, and the amounts and trends of construction and maintenance costs, in order to determine the feasibility of future programs by comparison with the expected total of future annual revenues.

The surveys are being conducted in the states under the direct supervision of the state highway departments through organizations especially created for the purpose. The Bureau of Public Roads is assisting with advice and suggestions in the conduct of all the surveys. It is hoped that the experience of the accelerated surveys will lead to the establishment of a permanent fact-finding and planning function in all state highway departments.

Henry Hudson Parkway and Its Traffic

By JAY DOWNER
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WHEN Westchester County built its main north and south parkways, it was realized that their connections in the Borough of the Bronx were inadequate. The pressure of traffic was there, but no effective steps were taken until about three years ago, when Commissioner Robert Moses took charge of New York City's park system with the result that, among the many recent improvements, we now have the Henry Hudson Parkway, opened for traffic in December 1936.

One of the main arteries for passenger-car traffic to the north through Manhattan has been the Riverside Drive. Extending from 72nd Street along the Hudson adjacent to Riverside Park for about seven miles, it discharged its heavy traffic on to city streets near the upper end of the island. Thence vehicles found their way as best they could over crowded thoroughfares with resulting conges-

AERIAL VIEW OF PARKWAY PROJECT FROM SOUTHERN END

tion, until they reached state highways; or if they could follow the tortuous connections to the city line, the several parkways of Westchester County would provide free movement of traffic.

THE HARLEM RIVER BOTTLENECK

The problem was to by-pass the bottleneck where Broadway crosses the Harlem River on a narrow drawbridge with approaches obstructed by elevated columns and burdened with the heavy truck and passenger-car traffic bound for the westerly side of Manhattan Island. Many studies had been made, but the cost of a new bridge over the Harlem River has heretofore blocked and discouraged official action. The serious congestion caused by this bottleneck is now relieved by the Henry Hudson Bridge and Parkway. Although it is now (January 1937) an infant of only one month in point of service (with northerly approaches still under construction), it has already assumed an importance and dignity reminiscent of maturity. In thus complimenting the parkway, I can renounce any personal credit because I had no connection with the construction except, in common with many engineers and civic officials, to encourage this extension of Riverside Drive to tap the Westchester County system.

To understand the objective and financial status of the parkway, reference may be made to the public announcement of no less an authority than Commissioner Robert Moses. He is the sole member of the Henry Hudson Parkway Authority, charged with the responsibility for the work. At the time the parkway was opened, Commissioner Moses characterized it as the first completed link in an express highway and parkway system that will extend the full length of Manhattan Island and the Bronx, tying into all the major arteries entering New York City. When the West Side Improvement in Riverside and Fort Washington parks and the West Side Express Highway south of 72nd Street are finished, a motorist will be able to enter this marginal drive at the Battery—the lower tip of the island—and travel north without interruption to the parkways of Westchester County. Through traffic will flow directly into it from the George Washington Bridge, the Holland Tunnel, and the new Midtown Hudson Tunnel.

Bridging the $4^1/_4$ miles from the Saw Mill River Parkway in Westchester to Riverside Drive, as noted in one of the photographs, the Henry Hudson Parkway is a vital unit in this new metropolitan highway system. It eliminates one of the worst traffic "sore spots" in the city by breaking the bottleneck across the Harlem River at Broadway and 225th Street. Starting at the city line, this new parkway cuts south through Van Cortlandt Park, then through a residential section known as Riverdale, to the bluff above the Harlem River Ship Canal. A high-level bridge carries it across to Inwood Hill Park, through which it curves to reach Riverside Drive just below Dyckman Street. It also will connect at this point with the parkway under construction as part of the West Side Improvement.

The project was the joint work of the city, represented by the Henry Hudson Parkway Authority, and the State Department of Public Works. The Authority, which was created by the 1934 Legislature, built the Henry

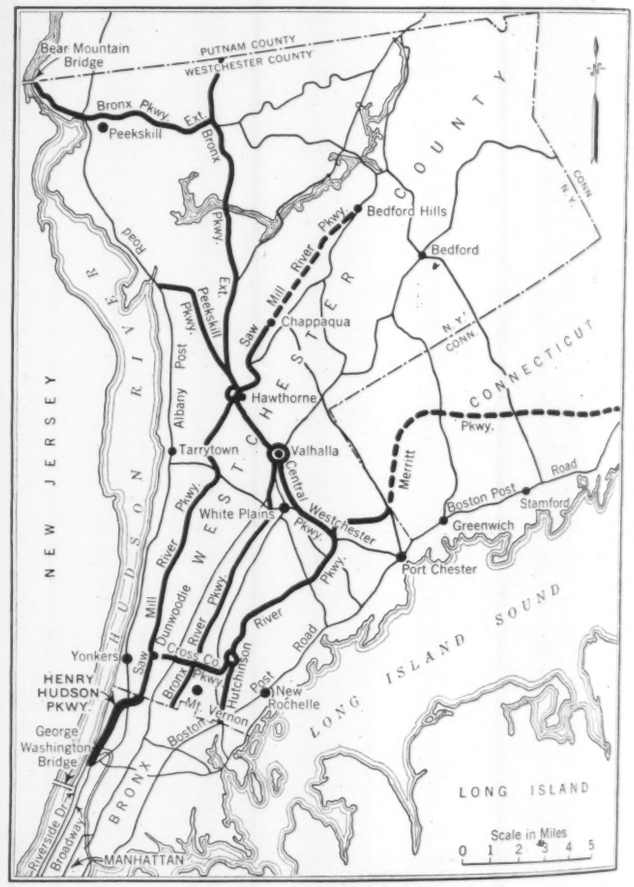

FIG. 1. WESTCHESTER COUNTY PARKWAY CONNECTIONS WITH HENRY HUDSON PROJECT

Hudson Bridge and the lower half of the parkway with the proceeds of a privately subscribed bond issue. The upper half, north of the Spuyten Duyvil Parkway, was constructed by the N. Y. State Department of Public Works with state and federal highway funds on rights of way acquired by the city and the Authority.

Outlining the development of the work, Mr. Moses explained that traffic and engineering studies for the

Fairchild Aerial Surveys, Inc.

HENRY HUDSON PARKWAY, SOUTHERN END, WITH ARCH BRIDGE OVER THE HARLEM

Inwood Park in Foreground; Riverdale Section Beyond; Hudson River at Left

improvement were made in 1934, and in the summer of that year work at the lower end was begun with relief labor. Throughout subsequent construction, relief labor continued to be used for grading operations and for the paving of service roads and sidewalks.

In January 1935, the city acquired the necessary right of way through the Riverdale section at a cost of approximately $1,260,000. The state started work on the northern $2^1/_4$-mile section in the spring of that year. Since then it has spent $2,750,000 of highway funds for grading, paving, and the construction of nine grade separations.

The Authority's bond issue of $3,100,000 was offered for sale in April 1935. About July, work was started on the $1,250,000 arch span over the canal. This structure was so located as to take advantage of the natural heights on each bank in providing adequate clearance for river traffic. It is 142.5 ft above mean high water at the center and has a total length from pier to pier of 840 ft. It is a fixed arch composed of steel plate girders. In addition to this bridge the Authority has built four grade separations and a ramp leading up to Riverside Drive.

According to the Authority's agreement with the bankers who floated the loan, they will advance an additional $1,400,000 for an upper deck on the bridge as soon as traffic tolls warrant it. At that time a second roadway will be built through Inwood Hill Park, and traffic will be made one-way on each deck. At present the 40-ft roadway through the park and over the bridge carries two lanes of traffic in each direction. North of the Harlem span, two 32-ft roadways separated by a central mall have been laid out, although they are only paved to 21 ft at present for part of the distance.

AMPLE CONNECTION TO WESTCHESTER

From this brief outline, based on Commissfoner Moses' description, the main features of the work will be apparent. At the southerly line of Westchester County the parkway connects with the Saw Mill River Parkway and the entire Westchester County system (Fig. 1), comprising 170 miles for which rights of way have been acquired, of which 94 miles are completed and under traffic. The Saw Mill River Parkway, now opened to Chappaqua, also connects with the Bronx Parkway Extension, which was built by the State of New York to the Bear Mountain Bridge approach, and which connects with the Eastern State Parkway. The latter extends through Putnam County (adjacent to Westchester on the north) and recently was opened up into Dutchess County, still further north, to within a dozen miles of Poughkeepsie.

Branching from the Saw Mill River Parkway at Dunwoodie, the Cross County Parkway, temporarily using a quarter mile of city streets, runs easterly and feeds into the Hutchinson River system, now open to the Connecticut state line. From this point, the Merritt Parkway, headed towards Bridgeport and further east, has some 14 miles graded. This should be ready for traffic later in 1937.

Thus we find that the new project is the only direct parkway connection between New York City's great West Side system, connecting with bridges and tunnels to New Jersey, and Westchester's far-flung parkways connecting with up-state New York and New England.

In order to build this very important link and by-pass for the congested Harlem River crossings, it was necessary to obtain extensive funds. After months of strenuous effort and many traffic surveys by various engineers, Commissoner Moses persuaded a group of wary bankers

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HENRY HUDSON ARCH BRIDGE OVER HARLEM SHIP CANAL

Longest Hingeless Steel Arch Has 800-Ft Span

to provide $3,100,000 against which the 10-cent tolls now being collected at the Henry Hudson Bridge were to be pledged. To get the remaining $6,000,000 to $7,000,000 ultimately required, Mr. Moses, with his characteristic energy and resourcefulness, proceeded to commandeer funds from all other available agencies, such as the U. S. Bureau of Public Roads, the State Highway Department, the City of New York, and WPA.

LOWER END OF THE HENRY HUDSON PARKWAY
Looking North from Fort Tryon Park

AT 232D STREET LOOKING NORTH
Bridge Construction Is Typical of That Used for Grade Separations

SOME TRAFFIC ESTIMATES

Based upon exhaustive traffic surveys and toll records of the Holland Tunnel and the George Washington Bridge, Madigan-Hyland, the consulting engineers, conservatively estimated that the Henry Hudson improvement, with its 10-cent toll at the bridge and free parkway approaches, would, in the 17 years 1937–1953 inclusive, earn $6,300,000 above operating expenses. Although this is more than double the amount of 4 per cent bonds issued, the estimate appears conservative. The bridge was opened to traffic on December 12, 1936, and collection of tolls began December 14. During the succeeding 35 days, December 14 to January 17, inclusive, tolls were collected from 368,598 cars, or an average of 10,531 cars per day. The George Washington Bridge, during these same 35 days, carried 8.171 per cent of its total traffic for the year 1936. If this 1936 ratio is assumed to hold for the Henry Hudson Bridge during 1937, it should carry more than 4,500,000 cars, or an average of 12,360 per day. Madigan-Hyland's estimate for 1937 was 3,560,000 cars, or an average of 9,750 per day.

Actually, however, the financial requirements for the first year will be met by a total of 2,690,000 cars, so that with experience thus far indicating 4,500,000 cars, the bondholders should be amply protected. The seasoned experience of this 10-cent toll route will be of particular interest to traffic engineers because it is in direct competition with a nearby free route. This alternate, along Broadway, is slightly shorter but is encumbered by heavy trucks, by elevated columns, and by a narrow drawbridge at the Harlem Ship Canal.

REGARDING THE FUTURE

It seems reasonable to predict for this new route a steadily increasing traffic, of which much will be drawn from competing thoroughfares, often shorter but not providing free movement. The Henry Hudson Parkway will materially influence traffic between New York City and Westchester County. In fact traffic on the Saw Mill River Parkway has already notably increased. But it will require two to three years to fully develop this influence. Fortunately data are available for accurate comparison with future traffic surveys so that eventually the extent of the influence of the Henry Hudson Parkway can be satisfactorily measured.

Under the direction of Commissioner Moses, Madigan-Hyland were the engineers in general charge of the project. Of this firm, Emil H. Praeger is chief engineer; Gilmore D. Clarke is consulting landscape architect on the project; and Robinson and Steinman and Waddell and Hardesty were consultants on bridge design—all Members of the Society.

Rural Zoning and Highway Improvement

By LAURANCE J. CARMALT
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BEFORE discussing the subject of rural zoning as related to highway improvement, it is desirable to clarify the terms used and the scope of the problem. The term "rural zoning" is used, not in the strictly legal sense of zoning outside incorporated areas, but to indicate zoning in rural districts as distinguished from urban or suburban districts, no matter how administered. The control unit may vary—it may be the city, town, borough, county, or state—but the legal limitations of land use constitute the problem to be considered.

The term "highway" is used to cover all major highways, whether state, county, or municipally controlled; and "improvement" refers not to the road structure but to its borders. Generally this is spoken of as "roadside improvement." Roadside improvement in rural areas may be subdivided according to its physical limits into

control of the right of way, control of the borders or roadside strips, and control of the countryside.

Only in a remote way can control of the right of way be associated with zoning, for within the right-of-way limits, the highway administration has complete control. The way in which the highway administration's power is exercised depends upon its vision and foresight, upon the funds at its disposal, and upon certain powers, mandatory or permissive, granted by the legislative body. Where the right of way is narrow, the most that can be done is to keep it as clear of obstructions as possible. If the right of way is sufficiently wide to permit adequate landscaping and to provide safe access from adjoining land, the highway administration can have some influence by example in inducing abutting owners to do their share in preserving the attractiveness of the open country.

A forward step along this line has been taken in some progressive areas where rights of way from 125 to 150 ft in width have been taken up in anticipation of heavy traffic. Under such conditions, provision can be made for the safety of through traffic by providing service roads and parking spaces entirely separate from the through lanes, with access to the latter completely under control. The same idea can be carried out with freeways and parkways. As all such rights of way become the property of the state, their control and use rest absolutely in the state, acting through its highway administration. Ample width is the controlling factor in this type of improvement.

THE VALUE OF BORDER RESTRICTIONS

The control of the borders through the zoning of roadside strips is an application of the police power similar to all other zoning. If control of land for distances up to 500 ft from the highway can be established, its enforcement will so regulate the private frontage that developments injurious to safe traffic operation can be prevented and the rural and natural features of at least that much of the countryside be preserved. A very able presentation of this form of control was given by Flavel Shurtleff, counsel for the American Planning and Civic Association, in its bulletin, *Planning Broadcasts*, for October-November, 1936, under the title, "Proposed Legislative Program for Roadside Improvement."

To summarize, control of roadside borders will prevent the improper location of billboards; concentrate commercial uses such as filling stations, repair shops, lunch rooms, and other roadside stands, and the normal commercial needs of the rural population at suitable places along the highway; and preserve for the enjoyment of travelers the natural features of the area. Although the provision of a controlled strip over 1,000 ft wide will go a long way towards our general objective, it has the drawback that it is limited in scope and is not under local but state control.

A NEW ENGLAND COUNTY ROAD THAT HAS BEEN RUINED BY UNDISTURBED EXPLOITATION

If balance between all phases of land use is desired, zoning of the countryside by local governmental bodies is necessary. This is true zoning as developed during the last 30 years, and is now thoroughly supported by judicial decisions. It would follow the accepted principles for segregation of the different land uses, as in the proposed control of roadside strips. To be effective it would have to be very closely coordinated with the general plan for the territory.

COUNTRYSIDE CONTROL RELATED TO HIGHWAY USE

In connection with the control of the countryside, it is important to consider the purpose of the highway, whether it is needed for local use only, for through travel only, or for both. (The term "local" is here used to designate traffic which does not extend further than the distance between two adjoining centers of population.) While no hard and fast rules can be established for these different classes, each has its own field, and individual conditions have to be taken into account when broad principles are applied.

The first class of road, that for local use only, is practically confined to feeder or "farm-to-market" roads. Unless they are hard-surfaced, they are rarely used for recreational purposes. Occasionally they are purely commercial, connecting a quarry, gravel pit, sawmill, or other local industry with a main highway. Except at intersections, roadside stands and filling stations have no place, and the question of roadside treatment becomes negligible.

The second class of road, that for through traffic only, includes the freeway and parkway, as well as by-passes around centers of population and other congested points. In establishing freeways and parkways, the state has by its very act recognized the desirability of controlling a wide right of way. A by-pass, however, is usually little more than a diversion of the existing highway, and the control

A NEW ENGLAND COUNTRY ROAD WITH UNDISTURBED BORDERS
The Natural Setting Is Sufficient Beautification

Head and Body of "Giant" from a Distance

Close-Up of Head Reveals Quarrying Disfigurement

TWO VIEWS OF MT. CARMEL, "THE SLEEPING GIANT," NEAR NEW HAVEN, CONN.

of its roadside extends over the customary limited right of way only. Although these by-passes are intentionally located through open country, the opportunity for controlling the abutting property has rarely, if ever, been used, even where zoning commissions exist.

In one case in Connecticut a by-pass of some $2^1/_2$ miles through open farm land was zoned for commercial use throughout its entire length, although the community concerned has a population of less than 15,000. As might be expected, the result is a slow, scattered growth of unsightly stands and industries, with billboards at frequent intervals, and a slow deterioration of such residences as originally existed. The highway department, although it has an active roadside division, has done no landscaping except at some intersection islands, having been discouraged from any attempts along the borders, where hot-dog stands, garages, filling stations, or factories might be established any day. Since the value of by-passes as a preventive of traffic congestion is being appreciated more and more, they afford an exceptional opportunity for developing the principles of roadside control, and they might well be used as an object lesson for further expansion.

In the third class of road, that for both through and local traffic, we have by far the greatest part of our highway mileage, but the relative proportions of through and local traffic vary greatly. For example, U. S. Route 1 carries a large proportion of local traffic between Philadelphia, New York, and Boston, in addition to the through traffic. Treatment of an artery such as this would probably be in a class by itself. But the thousands of miles of state highways throughout the United States for which two traffic lanes will amply suffice constitute the major problem. It is to them that the recreational feature so largely applies, and it is there that broad-scale zoning is essential.

RURAL AND URBAN ZONING COMPARED

In considering the different types of zoning applicable to our problem, we must bear in mind certain factors which influence rural rather than urban conditions. Zoning, like all phases of planning, consists in looking forward, in providing for future improvement. Under urban conditions we have to deal with a complex mass of individual interests which, through long habit, have become so established that the changes necessary to make a harmonious pattern are difficult to carry out.

Our urban zoning maps, in consequence, are usually unbalanced. The effect of enforcing them can thus be merely the prevention of worse conditions rather than the improvement of existing ones. It is only on the outskirts of metropolitan areas that we can really look ahead and give serious attention to the esthetic features which should accompany any balanced and harmonious development. Of course, some attention can be given to the esthetic phases even in built-up sections, but the results can be of local effect only, and can hardly form a part of a general comprehensive harmony.

In the country, however, the situation is very different. Individual land holdings are large; consequently, conflicting interests are relatively few. The territory as well as the population is more homogeneous, and the individual problems are apt to be similar and consequently can be more readily solved. What would be a major change in the city becomes only a slight alteration in the country, because of the larger open spaces. As a result the zoning regulations can be much simpler and more readily understandable. The rural population, to be sure, is more independent and less aware than city dwellers of the need for cooperative effort. However, since there are fewer individuals to deal with, a well-planned campaign of education, founded on a careful study of conditions, should secure early approval of the ordinance and map.

CORRELATING LOCAL AND GENERAL ZONING PLANS

Rural zoning maps should be correlated with the general plan of the territory. In the country, the problems of both are closely allied and are relatively simple, as they are both based on the same fundamental principles —the economics of land use and regard for the recreational and other social needs of the relatively sparse population. Because of their homogeneity, the two problems can be readily studied together, and the economics of roadside and countryside improvement can be brought more easily into the picture. Provision for wide rights of way, and for highway locations and alignments that will bring out the natural beauty and reduce construction scars, are worth-while details which should be studied when developing the general plan; vice versa, such zoning regulations as will segregate unsightly uses, and assign them to the less prominent locations, should be given special consideration.

In conclusion it may be said that the subject of the relationship between rural zoning and highway improvement presents many phases. This paper is merely an attempt to bring into the foreground the salient factors involved. The multiple aspects of the problem should not distract attention from our main objective—the improvement of state highway roadsides by means of different forms of rural zoning.

A Steel-Pile Pier in Tropical Ocean Water

Unusual Design Features and Construction Methods Used for Panama All-Steel Wharf

AT a session of the Structural Division on January 21, 1937, held as a part of the Annual Meeting of the Society, two papers were presented, one dealing with design and the other with construction of a noteworthy steel-pile pier on the southern coast of Panama. These are abstracted here for the information of members.

Among the more important design features described by Mr. Durkee are the omission of underwater bracing, use of the flexible theory for the design of piles to resist lateral forces due to earthquake shocks, wide spacing and unusually heavy loading of the piles, and the use of gunite concrete applied over the entire immersed lengths of piles before driving to guard against damage caused by the destructive marine growths common in those waters.

New and efficient construction methods limited the cost of the entire project to $302,500, as compared with an original estimate of $350,000. Unusual features, as described by Mr. Barnett, included the use of a caterpillar-mounted dragline with traveling outriggers; heavy timber lagging and gunite jackets for the steel piles; pre-drilling of piles on land; successful driving of piles to exact line and grade, facilitating the framing work; and painting of all steel on land before installation.

The Design of a Steel-Pile Pier

By E. L. DURKEE

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ASSISTANT ENGINEER, BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

PUERTO ARMUELLES, a small port in the extreme southwestern corner of the Republic of Panama, about 250 miles from Panama City, lies on the Pacific only a few miles from the border of Costa Rica. Armuelles is the newest of the United Fruit Company's many divisions in Central and South America, having been started by them during 1927. It is owned and operated by the company's subsidiary, the Chiriqui Land Company. The inhabitants number only a few thousand, but it is probably the most important port in the Republic of Panama outside the limits of the Canal Zone.

This section of the country is quite inaccessible, even now, from the rest of Panama. There is no highway leading out to Armuelles from the interior. All supplies are brought in almost exclusively by boat at Armuelles, and all local products leave in the same way. The nearest settlement is the old Spanish town of Concepción about twenty miles distant in the interior. The Panama Government extended its railroad line from Concepción to the coast when the United Fruit Company started operations, and the railroad company contracted for the design and construction of a pier to facilitate the shipment of supplies and produce.

A reinforced concrete wharf was designed and constructed at Puerto Armuelles about 1927 by the J. G. White Company, of New York, under a contract with the Panama Government, which leased it for operation to the Chiriqui Land Company. In July 1934, an earthquake destroyed about 360 ft of the outer end of the old pier.

The destruction of the concrete pier interfered seriously with fruit-loading operations, which had to be carried on by means of lighters entailing additional expense amounting to thousands of dollars per week. Therefore, the immediate construction of a new and adequate pier was imperative. To expedite matters the Chiriqui Land Company undertook to build a new structure for the Panama Government, to be paid for by the government out of rentals from the operators.

BIDS ASKED FOR NEW STEEL PIER

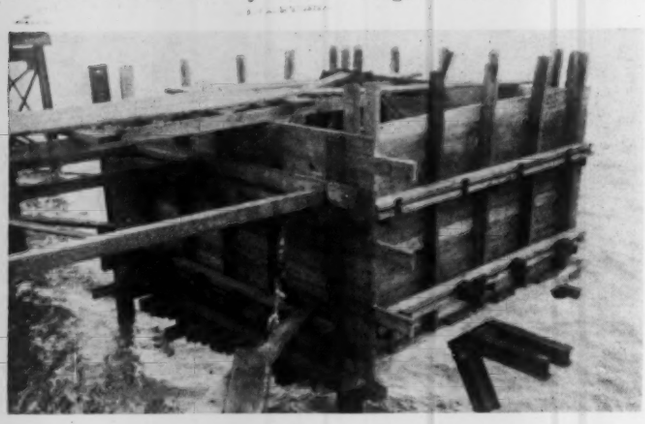
Bids and preliminary designs for a new all-steel pier with timber deck were asked for early in September 1934, and a formal inquiry, with general specifications, was released in October 1934. A contract for fabricating the approach section was let in February 1935, followed by the contract for the main pier late in March, both being awarded to the Bethlehem Steel Company. The erection was done by the United Fruit Company's own field forces.

Located in a relatively unprotected bay, the pier runs out into the ocean in a southeasterly direction a total distance of 1,532 ft (Fig. 1). The usual weather conditions are not severe, and bad storms are infrequent. The tidal range averages a little more than 7 ft and the maximum is 13 ft. The deepest water at the site is 54 ft, and

VIEW OF WATERFRONT AT PUERTO ARMUELLES, SHOWING OLD PIER AT LEFT, NEW PIER AT RIGHT, AND NATIVE QUARTERS IN THE FOREGROUND

there is a minimum of 36 ft on the side where provision is made for docking and loading of ships. The deck of the pier is 23 ft above mean low water.

The structure consists essentially of an approach section 20 ft wide by 960 ft long, a transition section



METHOD OF PLACING LOADING BOX ON TEST PILE

122 ft long in which the pier widens out to its full width of 61 ft, and the main section which is 448 ft long. The approach is supported on two-pile bents, 24 ft apart with expansion joints every 96 ft. In the main pier there are 4 piles to a bent, with bents spaced 20 ft $4\frac{1}{2}$ in. on centers. The main pier and transition section were designed as a unit, without expansion joints. Rolled steel floorbeams frame directly into the webs of the H-section steel piles in the approach, where the pile design is controlled by earthquake forces, and the H-sections are turned to give the greatest strength lengthwise of the pier, in which direction they have their greatest unsupported length. In the main pier the floorbeams frame to the flanges of the piles, which are turned in the opposite direction, so as to afford the greatest resistance to a transverse wind load, which here governs their design instead of earthquake forces. The floorbeams support longitudinal rolled-steel stringers which in turn carry the timber ties and planking. Typical sections of the main and approach pier are shown in Fig. 2.

A narrow-gate railroad track runs down the center of the approach. In the transition section it branches out into three lines which run the full length of the main pier. A shed covers two of the three tracks and the third track, outside the shed, is spanned by four new gantry-type conveyors for loading fruit into boats. There is also provision for the older type of conveyor, one of which was salvaged from the concrete pier. The new conveyors have four 11-ton wheel loads carried by a rail along the side of the pier on which the boats dock. The inner rail for these conveyors is supported on the side of the pier shed. A small office and a customs building are provided. A row of steel fender piles 3 ft from the structure protects the docking side of the pier, and a dolphin structure of silicon steel piles is located near the outer end. There is a lighting system, and water and oil lines for the servicing of ships.

The three railroad tracks are designed for Cooper's E-30 loading, plus impact, with not more than two locomotives on the pier at any one time. The deck outside the tracks is designed for a uniform load of 300 lb per sq ft on the main pier and 75 lb per sq ft on the approach. The wind load was assumed at 40 lb per sq ft on $1\frac{1}{2}$ times the exposed area of the floor, piles, and pier shed; and 40 lb per sq ft on the exposed area of the conveyors, customs house, and office building.

The specified loading resulted in extremely heavy pile loads, varying from 71 to 104 tons in the four lines, and quite unprecedented for piles in soft soil. To equalize the pile loads as far as possible, and to prevent unequal settlement under concentrated loading, an elaborate system of bracing was used between the piles, in both directions, above the water line. The four lines of longitudinal bracing, together with the transverse bracing, are designed to act as bridge trusses, and the system is capable of distributing a load of 100 tons over six panels. The actual maximum pile load, therefore, is estimated at only 73 tons for the specified design loading and 53 tons for the more usual conditions of loading.

EARTHQUAKE STRESSES PROVIDED FOR

The specifications required the pier to be designed to withstand an earthquake shock equivalent to a seismic coefficient of 10 per cent of the weight above any plane, acting horizontally in any direction. This was later modified because of the flexible type of construction used, and the horizontal force due to an earthquake shock was limited to either 10 per cent or one which would produce a horizontal deflection of not more than 2 in. in any direction. Wind and earthquake loads were not considered as acting simultaneously, as earthquakes usually occur during periods of intense calm.

Temperature stresses were considered only in the design of the relatively short piles of the approach section, where those piles outside the braced bays were designed to flex with temperature changes. These stresses did not affect the pile section. In the main pier

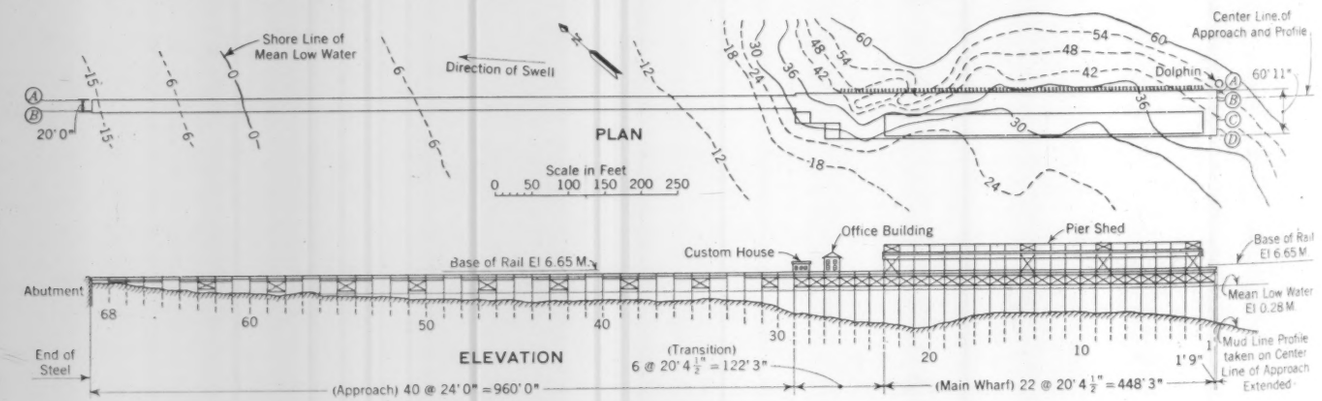

Shore Line of Mean Low Water
Direction of Swell
Center Line of Approach and Profile
Dolphin
60' 11"
20' 0"
PLAN
Scale in Feet
0 50 100 150 200 250
Office Building
Pier Shed
Custom House
Base of Rail El 6.65 M.
Abutment
Mean Low Water El 0.28 M.
Mud Line Profile taken on Center Line of Approach Extended
End of Steel
ELEVATION
(Transition) 6 @ 20' 4 1/2" = 122' 3"
(Approach) 40 @ 24' 0" = 960' 0"
(Main Wharf) 22 @ 20' 4 1/2" = 448' 3"

FIG. 1. PLAN AND ELEVATION OF PIER AT PUERTO ARMUELLES, REPUBLIC OF PANAMA

the piles were so long that temperature bending was small, the stress being much less than that from wind and earthquake forces.

Allowable unit stresses for design were based on the American Institute of Steel Construction Specifications for the design of steel structures, 1934 edition, or a basic unit stress of 18,000 lb per sq in., properly reduced for column action and laterally unsupported beam flanges. An increase of one-third was allowed in the unit stress for a combination of dead and live loads, with wind and temperature or with earthquake and temperature forces.

The structure was fabricated entirely of carbon steel. Copper-bearing steel was considered but was not used, as it was not regarded as sufficiently positive in resisting corrosion. The minimum thickness of metal used was $^{7}/_{16}$ in. for the piles and $^{3}/_{8}$ in. for the floor and bracing, except the webs of the top bracing struts, which were about $^{5}/_{16}$ in.

Previous to release of inquiries the United Fruit Company made a series of soil borings, which showed that the following conditions were quite uniform over the site: Mud, 0 to 2 ft; fine sand, 2 to 8 ft; fine sandy clay, 8 to 32 ft. This classification was based on ten samples analysed mechanically, particles between 2.0 and 0.05 mm being classed as sand, between 0.05 and 0.005 mm as silt, and those smaller than 0.005 mm as clay. Most of the material, although classified as sand, is quite fine, and a further analysis of it showed that 95 per cent of it would pass a 100-mesh sieve and 68 per cent a 140-mesh sieve. The average percentage of materials by weight for the various samples was as follows: Sand, 37 per cent; silt, 15 per cent; clay, 15 per cent; and water, 33 per cent.

Preliminary pile-loading tests indicated that although the soil was relatively soft, 40-ton loads could be carried by plain 8-in. steel H-piles, and by using larger sections and lagging them with timbers they could be made to carry loads well over 100 tons. The maximum load carried without excessive settlement by a 12- by 10-in. test pile, lagged with timbers and driven to 38-ft penetration, was 120 tons.

MANY UNUSUAL FEATURES IN DESIGN

Among the unusual design features which make this pier a notable structure are the omission of under-water bracing; the method of designing piles for lateral forces due to earthquake shocks; the wide spacing of piles and the unusually heavy loads carried by them; and the means used to protect them from marine growths.

The elimination of under-water bracing was required by the owners because of the impossibility of protecting it from corrosion in this locality. One advantage resulting from the elimination of such bracing is the increased flexibility of the structure, which makes it much less subject to damage not only from earthquake shocks but from the accidental blow of a ship. The structure is adequately braced above water, the entire wharf section being designed to act as a unit to minimize earthquake damage as well as to provide against the possibility of unequal pile settlement.

While at first the lack of under-water bracing seemed incompatible with fewer piles, it worked out very satisfactorily because the great depth of water and consequent unsupported length of pile, together with the slenderness ratio requirement, resulted in a pile section greatly in excess of direct load requirements. This permitted wide pile spacing, provided the piles could develop the necessary resistance in the soil.

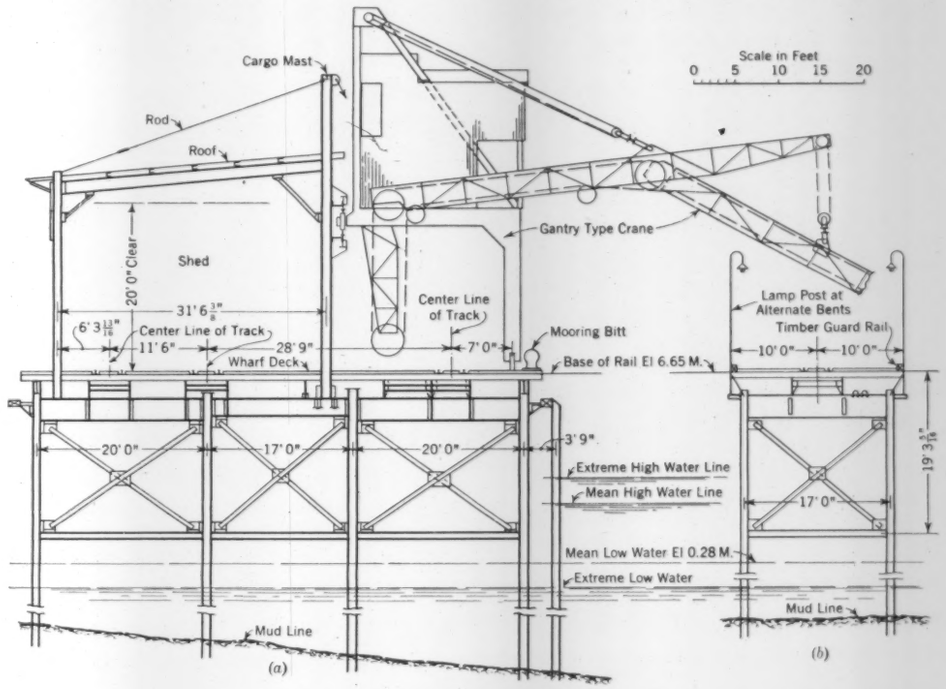
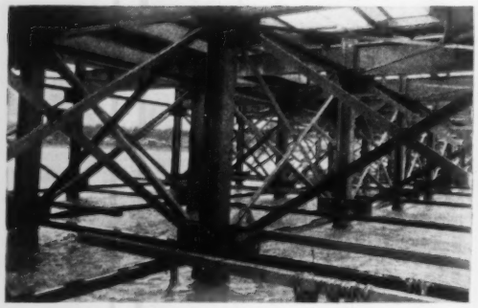


FIG. 2. TYPICAL CROSS-SECTIONS OF STEEL PIER AT PUERTO ARMUELLES
(*a*) Transverse Section of Main Pier (*b*) Transverse Section of Approach Pier

The determination of the proper penetration for the piles was a troublesome problem. The first estimates were based on the results of two preliminary pile loading tests which seemed to indicate hard driving and a high bearing power with relatively little penetration. More extensive tests indicated that these data were not typical, and later tests with a heavier hammer showed that beyond 30- to 40-ft penetration the resistance to driving a plain H-section did not increase very rapidly. Further load-bearing tests showed that the capacity of a plain H-section pile was erratic and subject to excessive settlement under heavy loads; that the necessary bearing resistance would have to be obtained by lagging the H-sections with timber, thus transforming them into displacement piles; and that 30- or 35-ft penetration would provide the necessary bearing with a factor of safety of about 2 with respect to a load which would cause excessive settlement.

For all piles in water over 30 ft deep, it was found that lateral stability against overturning from wind and earthquake forces governed the necessary length of penetration, which was fixed at from 40 to 44 ft. The assumptions used in figuring lateral pressures were based on a method suggested by M. A. Drucker's article, "Embedment of Poles, Sheeting, and Anchor Piles," in CIVIL ENGINEERING for December 1934. The method uses

a straight-line variation of soil pressure on the pile, and assumes that the pile is rigid as compared with the soil. The weight of the soil was assumed at only 60 lb per cu ft in calculating the passive resistance against overturning. The theoretical length of penetration required for any group was increased by one-third as a factor of safety. For the approach piles, the penetration used was 30 and 25 ft. The structure was adequately braced above water, thus fixing the piles at the lower bracing connection. At the lower end, the piles were considered as fixed at a point 10 ft in the ground. A point of contraflexure was assumed midway between these two points. For design purposes, however, three-fourths instead of one-half of the total length between the assumed fixed points was used as the effective length in calculating the column slenderness ratio, because of the uncertainties as to the exact elevation of the ground.



VIEW UNDER MAIN PIER, SHOWING HEAVY CONTINUOUS BRACING IN BOTH DIRECTIONS

In computing wind stresses, each bent was assumed as taking the load from one bay of the structure, and the bending and direct pile stresses were calculated accordingly. For computing stresses due to an earthquake, different assumptions were made. For the main wharf, the total dead and live load that could be placed on the structure was computed, and the location of the center of gravity of this load above the water was estimated. Ten per cent of this load was then applied at its center of gravity as a horizontal force acting in any direction, as one criterion for the design of the piles. This method of computing bending stresses due to an earthquake may be limited by what is known as the flexible theory for design, as opposed to the rigid method in which lateral forces are carried to the ground through diagonal bracing members.

FLEXIBLE THEORY OF EARTHQUAKE DESIGN

The justification of the flexible theory lies in the fact that the period and amplitude of earthquakes lie within fairly definite limits, and the maximum amount a flexible structure will move laterally under the influence of an earthquake shock is also fairly well known, provided the natural period of vibration of the structure does not coincide with that of the earthquake. The maximum movement suggested by L. H. Nishkian, M. Am. Soc. C.E., of San Francisco, who apparently suggested the method, is about $1^1/_2$ in. The maximum amplitude of a surface particle, excluding synchronism, is given by Creskoff, in his *Dynamics of Earthquake Resistant Structures*, as 0.25 in. in bedrock and 1.00 in. in dry or cohesive soil.

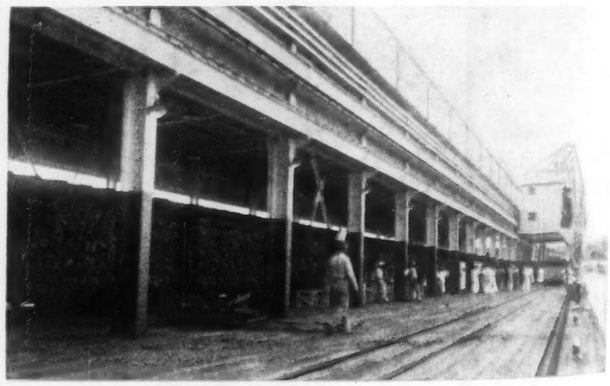
For the design of this pier a maximum amplitude of 2 in. was assumed, regardless of the amount of the lateral earthquake force. To determine whether or not this governs the design, the deflection due to the 10 per cent lateral load must be computed. This load must be distributed to the piles in proportion to their stiffness factors, or to the ratio of the quantity I/l^3 for each pile with respect to the summation of I/l^3 for all piles in any one unit of the structure, where I is the moment of inertia about any given axis, and l is the effective length of column.

For the pier design adopted, the H-section piles were so slender that the 2-in. deflection governed for earthquake design in most cases. The maximum calculated transverse deflection where wind controls is about 4 in. The vertical reactions resulting from the overturning moment were added to the other direct loads. In computing bending stresses, the moment from vertical loads acting over the horizontal deflection as a lever arm was added to the moment caused by horizontal forces, and in the case of wind load, which might be a steady force, this moment was increased by 10 per cent to provide for the additional or secondary deflection which it would cause.

An attempt was made to compute the natural period of vibration of the various units of this structure, between expansion joints. For a single pile this is not difficult, being given by the basic formula, $T = 2\pi\sqrt{\frac{A}{a}}$, in which T is the period of vibration, A is the amplitude of vibration, and a is the acceleration. A variation which is more useful for this kind of work is $T = 2\pi\sqrt{\frac{m}{e}}$, in which m is the mass of the vibrating body and e is the force that will produce unit deflection of the body. For a column of length l and moment of inertia I, carrying a load W, this can be reduced to $T = 2\pi\sqrt{\frac{Wl^3}{cEIg}}$, in which c is a constant depending on the end condition of the column, E is the modulus of elasticity of steel, and g the acceleration due to gravity.

For a group of piles acting as a unit, the period was determined by using the summation of the quantities $\frac{l^3}{cEI}$ for each pile, and using for W the entire weight supported by all the piles. This was done for the main pier, comprising 114 piles, for each of the three main axes. Transversely the period was found to be 1.9 sec; longitudinally, 2.9 sec; and at 45 deg, 2.2 sec. For the shortest single column the smallest period was found to be 1.6 sec in a transverse direction, and for the longest column it was 5.5 sec longitudinally. These values are believed to be well outside the so-called dangerous bracket of periods of 1.0 to 1.5 sec, and therefore to eliminate any possibility of the movement of the structure becoming synchronized with that of the ground during an earthquake.

Where it was necessary to use built-up H-section piles, welding was adopted both to avoid rivet heads which seem to be incipient points for the start of corrosion, and to seal the joints against the penetration of sea water.



DECK OF COMPLETED PIER OUTSIDE PIER SHED

A continuous 1/4-in. fillet weld was used the full length of each seam, except at the driving end, where it was increased to 1/2-in. for a length of 18 in. to withstand the impact due to driving.

Since splices in the piles were not desirable, it was decided to ship all piles in one length, provided they could be obtained from the mill, and provided also that ships could be found to handle them. Both these conditions were met, and the resulting sections, 120-ft maximum lengths, are believed to be among the longest single pieces of steel of their kind ever rolled, or ever handled by an ocean vessel.

PROTECTING STEELWORK FROM CORROSION

The protection of the steelwork, both above and below water, was given an unusual amount of thought because of the presence in these tropical waters of a destructive marine growth which has been found to cause deep pits and depressions in the steel, eating completely through it in from three to five years.

The method finally adopted by the United Fruit Company's engineers for under-water protection was a 2-in. coating of gunite applied before the piles were driven. It was originally conceived to be applied around the exact contour of the H-sections and to extend from about 5 ft below the mud line to a point about 1 ft above mean low water. Tests were made to determine if piles so treated could be successfully handled and driven without damaging or cracking the gunite, and this was found to be entirely feasible. The gunite was actually applied over wire mesh supported on square bars welded to the piles in the field, and spanning between the toes of the flanges so as to form a closed, square, box section.

The parts of the piles above water and the superstructure steelwork were given a single shop coat of synthetic base paint, composed of 50 per cent pigment and 50 per cent bakelite vehicle. The pigment was composed of 23 per cent zinc chromate, 48 per cent iron oxide, and 29 per cent reinforcing material. A field coat of bituminous enamel was used, but this has not proved satisfactory, peeling near the water line. Experiments with various paints and metallic coatings are being conducted at the present time. The shop coat has so far given better service than anything else tried.

The steel design was originated by the engineering department of the Bethlehem Steel Company's fabricated steel construction division under my direct supervision. Fabrication was at the Pottstown (Pa.) works of the same company. The entire weight of the structural steel work was 2,103 tons, of which 443 tons was in the approach. The 192 piles used weighed 985 tons, or 47 per cent of the total weight.

Features of Steel-Pile Pier Construction

By T. J. BARNETT
CHIEF ENGINEER, UNITED FRUIT COMPANY, BOSTON, MASS.

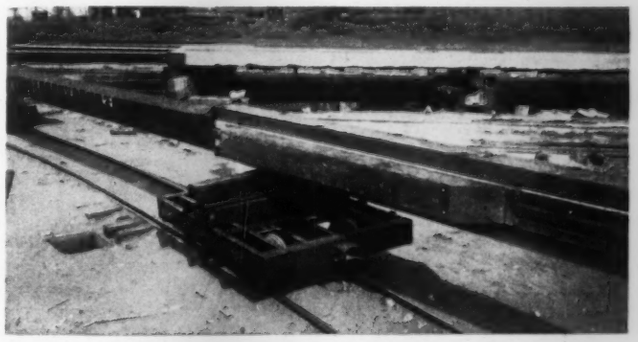
CONSTRUCTION of the Puerto Armuelles pier was undertaken by administration forces of the United Fruit Company. The organization consisted of a job superintendent, three foremen, and a job engineer—men long in the company's service on construction works, and all familiar with tropical conditions and the handling of Latin labor. The successful results obtained can be credited very largely to their ability and enthusiasm.

Work was started on April 1, 1935. The pier was completed and placed in service in November 1935, a period of approximately eight months being required for construction. The total expenditure for plant and equipment approximated $20,500. Care was taken to avoid purchasing specialized equipment which could only serve on this particular job. As a consequence the majority of the machinery and tools were those in standard use in the company's various works in Central America, and were available for service in other locations on completion of the work.

"SEAGOING" DRAGLINE USED

The largest piece of equipment consisted of a steam, caterpillar-mounted, full-revolving, dragline excavating machine weighing 64 tons, equipped with a 60-ft boom and a 190-hp boiler. This machine, which was used in pile driving, steel erection, and all crane work at the point of erection, had an ultimate crane capacity of 17 tons at a 35-ft radius. It had been discarded in one of our banana divisions and was reconditioned and set to work at a cost of $4,500. It was dubbed our "seagoing" dragline. The machine was found entirely adaptable to the requirements, gave complete satisfaction as to performance, and proved unusually versatile in handling the various phases of the work.

The dragline was operated on timber mats placed directly on the steel floor system of the pier, and traveled under its own power as the installation progressed. The railway track was extended as the machine moved forward, and all steel was delivered to the rear of the machine on cars pulled by a 14-ton gasoline locomotive. The dragline's full revolving feature made it possible to transfer the materials to the forward position, thus avoiding the necessity for using barges.



PILE WITH HEAVIEST TIMBER LAGGING AND GUNITE IN PLACE

Two fabricated steel traveling outriggers were used, with driving yokes in which piles were set and driven. They were designed by the engineering department of the United Fruit Company and constructed on the job at a cost of $1,900. While these outriggers were of an unusual design, they proved entirely satisfactory in performance. Most of the materials from which they were constructed were used in the permanent installation. These outriggers extended approximately 20 ft below the

deck, and thereby provided complete clearances for the operation of the revolving crane, rigging, and other erection operations.

Three pile hammers were available—one double-action steam hammer and two single-action hammers of different sizes. Special driving bases were used with the hammers for the driving of simple H-beam and built-up pile sections.

A compressor plant was installed, consisting of two 350-ft electrically driven air compressors, operated with a 140-cu ft receiver. Air pipe lines were carried throughout the construction yard and on to the pier for the operation of drills, riveting guns, gunite machine, and woodworking and other tools.

An open building 30 by 120 ft was erected in the construction yard for the preparation of the piles. This building was equipped with two 300-amp portable arc-welding machines, a gunite machine, two portable-type sandblasting machines, and a paint spray gun. A track of 10-ft gage was laid through this building, on which ran four sets of trucks ingeniously designed to carry the piles at the proper elevation and to permit them to revolve, facilitating guniting, sandblasting, and other work.

A plant was installed for washing, screening, grading, and drying of sand, and a warehouse was used for the storage of materials and the preforming of the wire fabric used as reinforcing for the gunite jackets. For general service in discharging, handling, and loading steel and other materials in the construction yard, a caterpillar-mounted dragline machine, available from the company's excavating equipment, was used for crane service. This machine proved particularly advantageous, in that its working range was not limited. A diesel-operated locomotive crane, located in the division, was also used for general crane service.

The delivery of steel involved unusual problems, as the piles for the main structure ranged from 60 to 120 ft in length and weighed up to 7 tons. The successful discharging and handling of this cargo were of particular importance in that the piles were of individual design. If one had been lost overboard or damaged beyond repair, it would have been necessary to replace it by re-rolling and delivery from the United States.

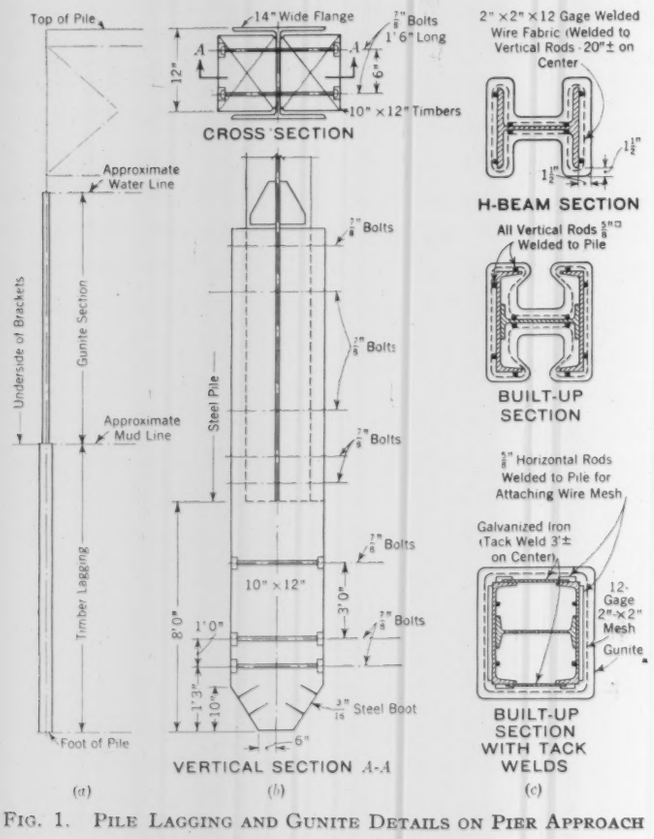


FIG. 1. PILE LAGGING AND GUNITE DETAILS ON PIER APPROACH

(*a*) Extent of Lagged and Gunited Sections of Pile
(*b*) Cross-Section and Vertical Section of 10 by 12-In. Lagging
(*c*) Pile Sections Showing Reinforcing for Gunite

MUCH WORK DONE ON PILES BEFORE DRIVING

Before a pile could be driven, it was necessary to install timber lagging over its penetration length, and to sandblast, attach reinforcing, and gunite the part to be immersed, as indicated diagrammatically in Fig. 1 (*a*). Furthermore, it was necessary to drill all holes for field connections of floor beams, struts, and bracing.

For the approach section, the lagging of each pile consisted of two untreated rough Douglas fir timbers 25 ft in length, placed on each side of the web and securely bolted together, as shown in Fig. 1 (*b*). Bolts were countersunk to prevent shearing of heads and nuts during driving. The lagging extended 8 ft beyond the end of the pile, and sheet-steel boots were lagged to the chamfered end. The upper end of the lagging terminated 8 ft below the mud line. As these timbers are completely embedded in the ground, they should not deteriorate. A metal bracket with stiffener plates is welded to the steel pile at the top of the lagging to further secure the lagging and to provide a seat for the gunite jacket.

For the dock section, the length of all lagging timbers was increased to 30 ft, owing to the greater penetration and increased pile loadings. With built-up piles, timbers were bolted to the I-beam web and the backs of the channels forming the flanges. For the rolled H-beam piles, timbers were bolted to the web only. The lagging terminated 2 to 3 ft above the end of the pile. As this provided a more suitable driving point, it was found sufficient to chamfer the timber, and the metal boots were omitted. The top of the lagging also terminated 8 ft below the mud line as before.

Although we had no precedent to follow in adopting this lagging method, it proved entirely successful from an installation standpoint. The cost of lagging the approach-section piles was $47 each, and the dock-section piles, $90 each.

All piles were sandblasted throughout the length to be covered by the gunite jackets, to obtain a thoroughly clean surface. The cost of this averaged $11 per pile.

After sandblasting, the reinforcing for the gunite jackets was applied to enable them to withstand the extreme stresses and shocks while being driven. This consisted of arc welding square steel bars placed horizontally at frequent intervals over the perimeter of the piles, to which was tack-welded the preformed sections of galvanized wire mesh, as shown in Fig. 1 (*c*). The cost of applying the reinforcing averaged $41.57 per pile. After the reinforcing was installed, a coat of coal-tar was sprayed on as a further precaution against corrosion and to provide a bond between the gunite and the steel.

APPLYING GUNITE JACKETS

Specifications for the application of the gunite jackets called for a 2-in. thickness around the entire perimeter of both H-beam and built-up piles. Actually the thickness applied averaged nearly 2½ in. For piles in the approach and transition sections, the gunite was successfully applied to the actual perimeter, although this was found difficult and involved considerable waste of ma-

terial. This was particularly true of the built-up piles where the contour inside the channel flanges was almost inaccessible. Here application resulted in waste of materials and loss of time in production.

To overcome this condition for the 96 piles in the dock section, most of which were of the built-up type, a strip of sheet metal was tack welded across the flanges of the channels, forming box-section piles. At the top and bottom ends of the jacket, the area inside the channels was entirely closed in with a solid plug of gunite 2 ft thick, properly reinforced. This change was of vital importance to the job, for it reduced the surface to be gunited, eliminated considerable waste, doubled production, reduced the amount of cement and aggregate required, and reduced the resultant weight of the long piles within the working limit of the erection crane. It also made it possible to obtain a better grade of gunite product.

The gunite machine operated two guns with air pressure maintained on the gage at 50 lb. A 1:4 mix was used. For the piles in the approach section a special high-silica cement was used, but standard portland cement was employed for the dock-section piles.

For the gunite aggregate and for sandblasting, a coarse beach sand containing pea gravel was obtained at the site. It was thoroughly washed, screened, and dried before using. Laboratory analysis showed it to be well proportioned, paralleling a typical coarse sand with a fineness modulus of 3.74. The moisture and silt contents were low. The total cost of sand preparation averaged $41.57 per pile, the same as the cost of applying the reinforcing.

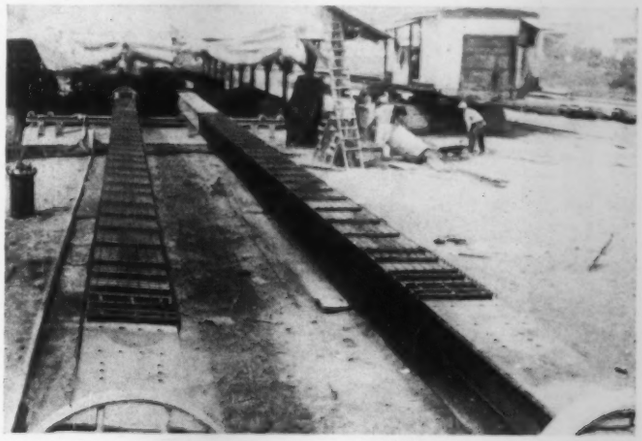
COST OF GUNITE AND LAGGING JUSTIFIED

A very satisfactory gunite product was obtained. Compression and absorption tests of three samples of the gunite applied to the piles, made by the Thompson and Lichtner Company, gave a compression strength of from 6,720 to 7,540 lb per sq in. Their report stated that the compressive strength and absorptions were good; that the gunite was dense and uniform; and that there was no evidence of corrosion of the wire mesh. The unit cost of the gunite was $1.76 per lin ft of pile, or $0.18 per sq ft; and the complete cost of applying the gunite jackets, including all operations previously described, amounted to $0.80 per sq ft, or an average of $215 per pile.

The cost of the gunite and lagging may not appear warranted. The use of lagging, however, made it possible to adopt a design permitting long spans with heavy pile loadings. The total steel tonnage, exclusive of conveyors, amounted to 2,344 tons, which was approximately 30 per cent less than for other designs made on the basis of the usual pile loadings. This saving in steel alone more than warranted the lagging cost; however, the principal saving obtained was due to the reduced cost of installing fewer piles, the general simplicity of construction, and the increased speed in completing the entire structure. It must be remembered that the time factor was of particular importance on this job, where the increased cost of loading bananas, without wharf facilities, exceeded $10,000 per month.

As to the cost of the gunite jackets, their use made possible the adoption of a steel-pile structure which was the most suitable under prevailing conditions, by providing protection for the steel. A design containing the minimum number of piles was all-important from the standpoint of the gunite jacket. In fact, from a cost standpoint, it made the use of gunite jackets possible, and the designers are to be particularly commended.

After the piles were gunited they were allowed to cure for six days. During this time they were covered with sacks and frequently sprinkled. After curing, the piles were stored until required. While in storage, a heavy coat of coal-tar was applied to the entire surface of the gunite jackets to seal any hair cracks and to act as waterproofing. Another operation that took place while the



REINFORCING IN PLACE READY FOR GUNITING

piles were curing and in storage was the drilling for field connections. This was an unusual procedure for which we had no precedent. On observing the driving of the first few bents, our job superintendent, R. C. Burton, had proposed drilling the piles before driving, as he felt it would be possible to drive them to exact grade. The importance in saving time and money warranted a trial, and this method was found entirely practicable. Pile drilling was done at a unit cost of $0.12 per hole.

All steel, including the pile lengths above the gunite, was given a heavy brush coat of bituminous enamel over the shop coat before installation. Undoubtedly a more thorough job was obtained by this procedure. After installation, all damaged or scratched surfaces were spot-painted. The painting cost amounted to $4,987, or $2.88 per ton of steel. Paint results to date, above the water line, are satisfactory. Although the shop coat with Bakelite vehicle has proved more resistant in the area subject to immersion by the tide, the bituminous enamel has proved unsatisfactory within these limits.

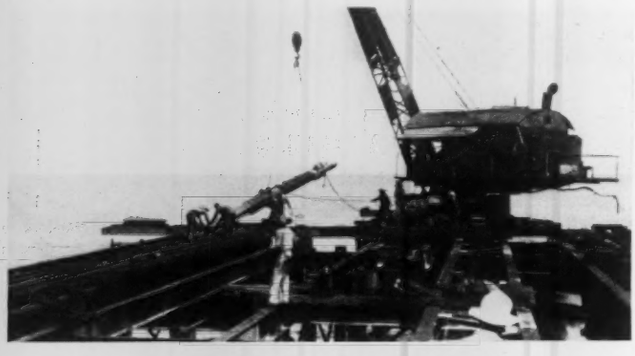
PILE-DRIVING PROCEDURE

Piles for the bents within the tidal beach area were driven with the dragline located on the beach, as there was not sufficient depth below deck over this section to permit the use of the traveling outrigger. Piles for these bents were set in a framed timber template before being driven. A stratum of gravel was encountered below the surface over this area, which made driving conditions much harder than elsewhere. These piles were driven to a penetration of from 38 to 40 ft. They were first jetted to a depth of 10 to 20 ft to obtain sufficient drift to set the hammer on the pile. The last foot of driving required from 150 to 200 blows. The piles over this tidal beach area were not gunited before driving, as it was possible to install concrete boxes around them after driving.

After a trial, the double-action steam hammer was discarded in favor of the larger single-action hammer, because its extreme striking force of 19,000 ft-lb was causing battered and upset pile ends. Also, the striking period of 67 blows per minute set up extreme accelerated vibration in the pile, apparently causing it to oscillate

close to the period of the hammer blows and tending to damage the tops of the gunite jackets. The single-acting hammer had a striking force of 15,000 ft-lb and a much slower striking period. With it, no difficulty was encountered with battered pile ends or damaged gunite jackets.

When pile-driving in the bents over the tidal range



CRAWLER CRANE HANDLING PILE PREPARATORY TO DRIVING

was completed and floor-system and bracing erected, the caterpillar machine was brought to the top of the deck and the traveling outrigger installed. Piles were often driven to within one millimeter of exact elevation. Little twisting or running of piles was experienced, and in such cases there was no difficulty in pulling them to position. No difficulty was experienced in making the field connections.

The addition of gunite jackets and lagging resulted in a varying pile perimeter, which made handling and driving conditions more difficult. However, the piles were set, plumbed, held in the yokes, and driven to exact position and grade with remarkable success. A base line and back sight were established on land for the two pile lines in the approach section, and piles were set to line and plumbed by instrument. Elevations for driving piles to exact grade were also given by instrument.

Beyond the tidal beach area, the penetration of the approach section piles ranged from 30 to 38 ft. As the structure extended into the bay, the penetration increased, and for the longer dock-section piles it ranged from 38 to 47 ft. Driving results were very satisfactory, although there was a tendency for driving to become easier in spots over the outer section. In such cases, additional lagging timbers were used.

For the last foot of penetration of piles in the approach section, the average number of blows required with the larger single-acting hammer ranged from 30 to 60, while the average for the dock section ranged from 30 to 45 blows, and from 50 to 65 blows with the smaller, single-acting hammer. These averages were occasionally greatly exceeded.

Frequent checks by instrument were made during the construction period to determine any settlement in the piles after driving and loading. After the piles were driven and the floor system installed, the 64-ton dragline was moved forward at once for work on the following bent, which resulted in almost immediate loading of the piles. As there was material vibration in the structure at this time, caused by the swinging and shifting in handling heavy eccentric loads and by the machines pounding during pile driving, undoubtedly they received a severer test than will be experienced during operation of the pier.

It was found that during these operations there was practically a constant initial settlement of approximately $1/2$ in., and that no further settlement took place thereafter. To conform with this condition, piles were driven to an elevation $1/2$ in. above true grade. Checks one year after the pier was placed in operation show no further settlement. The unit labor cost of driving piles amounted to $2.06 per lin ft of penetration, or $0.95 per total lin ft of pile.

When it is considered that these heavily lagged piles, having a displacement equal to a 12 by 27-in. solid pile, or more, were driven to an average penetration of 45 ft on the dock section; that the total number of blows per pile reached as high as 836, or 42 for the last foot of penetration; that they received considerable handling and deflection before driving; and that three piles were driven only 7 days after being gunited (although the average was from 10 to 25 days), there can be little doubt as to the success of the method.

In driving seven of the dock-section piles, the top 2 ft of the gunite was damaged where the plug was installed, owing to defective welding of the reinforcing rods in the top plug, as well as to the elimination of some of the rods. Their failure cannot be attributed to driving. As the top of the gunite extended more than 3 ft above low tide, this was repaired by casting a concrete box around the damaged gunite. It was further demonstrated that the success of the method was directly dependent upon thorough and first-class workmanship.

ARRANGING SCHEDULE FOR STEEL ERECTION

As the driving progressed, the driving crew also placed and rigged all floor beams, floor system, struts, and bracing, by temporarily bolting them. The lower bracing connections were only a few feet above low water, and at mid or high tide were completely immersed. This condition called for careful planning and scheduling of the work on the part of both the erection and riveting crews. As near as possible, piles were set at low tide, driven during high tide, and the lower connections framed on the following low tide. Riveting of the lower connections could only be done during periods of low tide, which only offered about two hours of working time with each tide. Riveting gangs followed the erection crew. The floor-system steel was completely installed at a labor cost of $27.50 per ton.

After driving the piles at the extreme end of the pier, the erection crew with the dragline drove the steel-pile dolphin off the corner of the pier. The dragline then traveled backwards over the deck, driving the steel fender piles and erecting the steel shed, posts, and running rails for the banana conveyors. Upon reaching the shore end of the shed, it erected the four 44-ton steel framed banana conveyors used for loading ships. In these operations the caterpillar-mounted machine proved to have further advantages over specialized driving equipment.

Ties were of creosoted sawn southern yellow pine, held in place by hook bolts. Over the ties was spiked 3-in. structural-grade Douglas-fir planking, treated to retain $3/4$ lb of chromated zinc chloride per cu ft to serve as the floor surface on the approach section. On the dock section, 3-in. southern yellow pine planking was used, having the same zinc chloride treatment. The installation cost amounted to $14.91 per thousand fbm.

The total cost of the pier, which has an area of 53,180 sq ft, amounted to $302,454.32, exclusive of the conveyors, or $7.00 per sq ft, of which $2.00 comprised labor cost. This compared favorably with the estimated cost of $350,000 if constructed by the United Fruit Company's forces, or $375,000 if constructed by an outside contractor.

Reports of Research Committees

As Prepared for the Annual Meeting of the Society in New York on January 20, 1937

Special Committee on Hydraulic Research

THE SPECIAL Committee on Hydraulic Research was appointed in 1934 and has had a meeting every year. The committee has adopted for its principal activity, the general advancement of knowledge in the field of hydraulic research, with emphasis on open-channel hydraulics and model tests.

CONFORMITY OF MODEL TO PROTOTYPE

One phase of the activities of this committee is the promotion of tests on full-sized structures to verify the results of previous hydraulic-model tests. Facilities for comparing prototype behavior with previous model performance are being installed in hydraulic works now under construction. Among such are the Bonneville and Fort Peck dams, and other dams and spillways now being built by the Tennessee Valley Authority and the Bureau of Reclamation. Similar tests in connection with the Madden Dam in the Canal Zone are being arranged. Steps are also being taken to obtain model experiments of the Miami Conservancy Dam outlets to compare with the results of observations made on the prototype.

Obviously the important phases of behavior in the full-sized structure can only be observed during extreme hydraulic conditions, such as flood periods, and many years may elapse before the corresponding critical conditions studied in the models can actually take place.

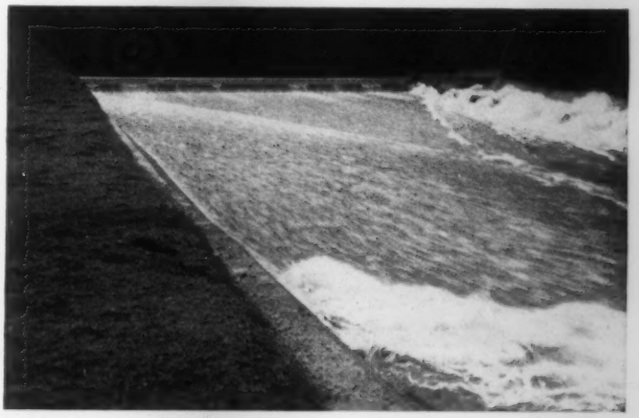
One paper has appeared on this subject during the past year from a member of the committee, "Hydraulic Laboratory Results and Their Verification in Nature," by Herbert D. Vogel, Assoc. M. Am. Soc. C.E., TRANSACTIONS, Vol. 101 (1936).

PROBLEMS ON FUNDAMENTAL RESEARCH

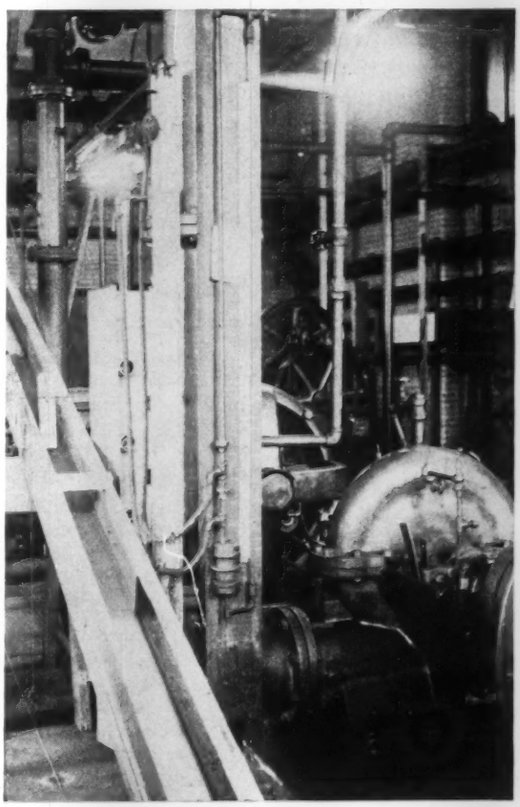
A number of problems on fundamental research have been assigned to directors of laboratories who have then been designated as cooperative members of the committee. The emphasis is to be placed on the physical phenomena involved, not merely the determination of losses, and hence these problems are as much problems in physics as in engineering.

Five such problems have been accepted and work is now under way. An appropriation of $1,500 has been received from the Engineering Foundation to further this work, and these funds will be expended entirely for materials used in the research work.

Project 1. "Traveling Waves on Steep Slopes," H. A. Thomas, M. Am. Soc. C.E., Carnegie Institute of Technology, Pittsburgh, Pa. Professor Thomas has devised a flume whose bed is a motor-driven endless belt. In this manner waves produced in the flume are caused to remain stationary for study.



FLOW OVER THE SPILLWAY AT BROWN LAKE, VICKSBURG
Later Reproduced in a 1:20 Scale Model



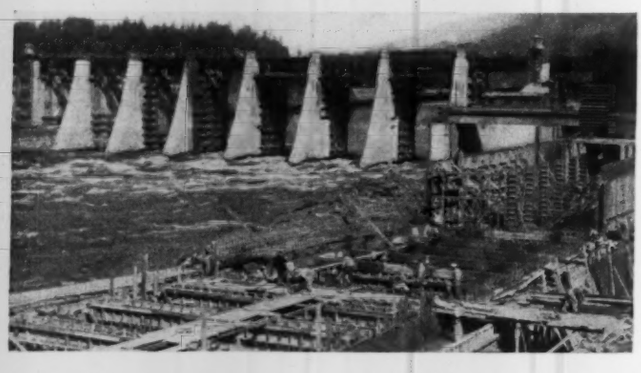
APPARATUS FOR STUDY OF WAVES IN A STEEP FLUME
Committee Research Project No. 1

Project 2. "Curves in Open Channels," C. A. Mockmore, M. Am. Soc. C.E., Oregon State College, Corvallis, Ore. Dr. Mockmore is constructing various types of bends in transparent pyralin with varying lengths of straight channel between them. The character of the passage of the water around the bends can be thus recorded photographically. He is also using equivalent lengths of straight channel in order that the friction losses may be ascertained independently of the curve losses.

Project 3. "Phenomena of Intersecting Streams," M. P. O'Brien, Assoc. M. Am. Soc. C.E., University of California, Berkeley, Calif. Professor O'Brien is experimenting with a long metal flume, to which is attached a branch flume whose angle of incidence can be varied through a wide range. It is anticipated that the junction will be constructed of transparent pyralin so that the currents and eddies can be photographed.

Project 4. "The Conversion of Kinetic to Potential Energy," F. T. Mavis, M. Am. Soc. C.E., Iowa Institute of Hydraulic Research, Iowa City, Iowa. Dr.

Mavis has first made an exhaustive search of literature on this subject in all languages, and is preparing for an intensive study of the phenomena involved in this obscure process as applied to flowing water. Considerable time has necessarily been consumed in developing technique. The



CONSTRUCTING THE SPILLWAY AT BONNEVILLE DAM

apparatus used so far consists of transparent pyralin cones. These, and the connecting tubing, are submerged in a glass-walled box through which the flow of the expanding fluid may be photographed by a motion picture camera.

Project 5. "Sedimentation at the Confluence of Rivers," L. G. Straub, Assoc. M. Am. Soc. C.E., University of Minnesota, Minneapolis, Minn. Dr. Straub has already conducted a number of experiments on this subject and expects to attack the problem vigorously upon completion of the new hydraulic laboratory. The laboratory is expected to be put into operation in the winter of 1937.

Research problems of a simpler nature have been supplied to students at universities on request, but this activity will not be continued.

MANUAL OF HYDRAULIC LABORATORY PRACTICE

The committee is preparing an up-to-date manual on hydraulic laboratory practice to aid in securing greater uniformity in the method of approach to the solutions of practical problems by model studies. The contents of the manual have been divided into the following four sections: (1) Historical summary, (2) principles of similitude, (3) practical applications of the laws of similitude, and (4) construction and operation of models. These have been assigned to various members of the committee under the general editorship of Dr. Straub. It is hoped that a tentative manual will be ready in mimeographed form during the ensuing year.

TRANSLATIONS AND ABSTRACTS

The committee is cooperating on a project originated by Donald P. Barnes, Jun. Am. Soc. C.E., of Denver, Colo. He has undertaken to secure English translations and abstracts of notable papers on hydraulics originally appearing in other languages. As fast as these papers are completed, they are sent in to Society Headquarters. When a sufficient number have been secured, it is hoped to have them published as a special number of PROCEEDINGS. To date, 6 such papers have been filed and more are in preparation by members of the committee and others.

SYMBOLS FOR HYDRAULICS

A set of letter-symbols for use in hydraulic laboratories has been tentatively adopted by the committee and published in the January 1937 issue of CIVIL ENGINEERING on page 84. While these symbols are perfectly general in the field of hydraulics, they were made up with particular reference to open-channel work in hydraulic laboratories. They may be considered as an elaboration of those given in the Society's Manual No. 11, and those of the American Standards Association published in CIVIL ENGINEERING for July 1934. The committee invites any discussion or suggestions regarding these symbols.

The committee, which was appointed in 1934, consists of the following members:

J. C. STEVENS, *Chairman*

HERBERT D. VOGEL	HAROLD A. THOMAS
CLARENCE E. BARDSLEY	C. A. MOCKMORE
EMORY W. LANE	M. P. O'BRIEN
LORENZ G. STRAUB	F. T. MAVIS
Members	D. P. BARNES
	Cooperating Members

CHILTON A. WRIGHT, *Secretary*

Committee on a National Water Policy

YOUR COMMITTEE on a National Water Policy serves (1) as an advisory group to the Water Resources Committee, which is a part of the National Resources Committee of the federal government, and (2) as a contact agency to inform the Society of the activities of that committee, and to present to the Society such recommendations or criticisms as seem desirable.

Your committee was appointed in November 1935. No funds have been allotted to it by the Society. However, through the courtesy of the National Resources Committee, several joint meetings have been held in Washington. Your committee endorses the following general functions with reference to the work of the National Water Resources Committee:

1. A coordinated, unified national policy is needed; the constituent parts of such a policy must be mutually consistent.
2. Planning under such a policy should be made cooperatively with state authorities. In most cases, a given drainage basin should be treated as a unit.
3. Systematic collection and publication of fundamental data on hydrology and meteorology should be promoted.

Hydrologic Data—The National Water Resources Committee and its predecessor, the Mississippi Valley Committee, have made a definite and valuable contribution to essential hydrologic knowledge. It supervised the work embodied in the U. S. Geological Survey Water Supply Papers Nos. 771 and 772. Paper 771 relates to flood data, and in its preparation the Society's Committee on Floods acted as advisory representative. On Paper 772, entitled "Rainfall and Runoff," a committee of the American Geophysical Union served as outside advisers. Important developments have been made within the last ten years in hydrology and meteorology, largely by individual investigators. These Water Supply Papers analyze the investigations and supplement them.

Most engineers approve the collecting of basic data by federal agencies, but many have not approved of their engaging in studies and conclusions. However, it is doubtful whether the research studies just noted could have been undertaken by other than an agency of the federal government because of the cost and the wide expanse of territory involved. Few designers have

either the time or the means to utilize undigested hydrologic data. It is a long road between tabulation of records, fact finding, and specific conclusions.

Your committee commends the work entitled "Standards and Specifications for Hydrologic Data, November 6, 1935," as a procedure suited to immediate needs. This work has been published as Appendix V of "Deficiencies in Basic Hydrologic Data" (U. S. Government Printing Office, 1936). Continued adherence to standardization has been a pronounced fault and a hindrance to progress in many bureaus. The work of the Water Resources Committee has materially improved this situation.

The report, "Deficiencies in Basic Hydrologic Data," pertinently states that there can be no sound, nationwide development of water resources unless certain deficiencies in data are remedied. This report was prepared by the Special Advisory Committee of men experienced in the use of data on precipitation, stream flow, and underground water. Six of the eight members of this committee were engineers in private practice. Their recommendations to Congress are outlined in the paper by Thorndike Saville, abstracted in this issue.

In the opinion of your committee, the customary procedure, that federal appropriations for maps and gaging be contingent upon an equal appropriation by the state, should, with the exception of base stations, be adhered to.

Your committee endorsed the recommendation for securing additional basic data contained in the aforesaid report, with the exception of Chapter VII relating to stream pollution and federal water analysis.

Water Supply—Your committee, together with a similar advisory committee of the American Water Works Association, met January 22, 1936, in conference with the National Resources Committee, with reference to a national inventory of water works, proposed to be made under the supervision of the National Resources Committee with the assistance of interested national engineering societies. Your committee is of the opinion that such a work is in demand by water works engineers. No inventory of water works of value now exists. Data relating to operation would aid in future designs. Such a nationally managed inventory would eliminate the wasted effort of the many questionnaires which have been sent from time to time. Your committee made detailed recommendations to the National Water Resources Committee on January 20, 1936. A copy is on file in the office of the Secretary of the Society.

Water Pollution—Your committee finds that, in general, the state agencies concerned with stream pollution are active and competent. They are making the essential water analyses. They are forcing the abatement of stream pollution in accordance with local sanitary requirements and its economic values. Interstate agreements have been entered into on the Ohio and on the Great Lakes basins. The existing U. S. Public Health Service is now adequate for handling any federal interests on interstate waters in cooperation with the state agencies.

Your committee recommends that, with the maintenance of the present work of the U. S. Public Health Service, the control of water and stream pollution be left entirely in charge of the states.

Flood Control—It is important that a planned program for flood remedial works and measures be instituted. It should be a continuing program, based on the recent advance in scientific and engineering knowledge and the consideration of sound economic values. It should recognize the fact that regulation to even approximately uniform flow is physically impossible on most streams. No general panacea for flood relief exists. All remedial measures should be considered, including the possibilities of drainage-basin diversions of flood water. Relief from floods should include betterment in forecasting storms, runoff conditions, and river stages. In the selection of flood remedial works no measure should be adopted without estimating the definite quantitative effects.

CONSTRUCTION ON THE ALL-AMERICAN CANAL, A UNIT OF THE MULTI-PURPOSE BOULDER CANYON PROJECT

The Harnessing of the Colorado Is an Example of Comprehensive River Development Requiring the Cooperation of Many Governmental Units

Inasmuch as major floods are due to widespread meteorological conditions and in their course spread through many states, your committee is of the opinion that measures for relief from floods are primarily a function of the federal government. The flood works call for state cooperation. Your committee endorses the recommendations contained in the report of the National Resources Board of November 1934, page 273, reading in part as follows:

"As a basic policy until such time as studies herein indicated suggest revision, it is recommended that federal contributions be made (*a*) only where there is reasonable protection against major floods; (*b*) only where the total benefits justify the expense; (*c*) only where there are responsible and legally constituted authorities with which to deal; (*d*) to an extent not greater than 30 per cent of cost of labor and materials where the benefits are chiefly local; (*e*) to an extent greater than 30 per cent only in proportion to benefits definitely applicable to recognized national interests; (*f*) to a full 100 per cent only where the benefits are almost fully of national interest. . . ."

The National Resources Committee, by its Water Committee, should act as the guiding agency on federal flood remedial work and should continue its researches.

It is well qualified by virtue of its special executive authority, its past studies, its effective contact with state authorities, and the essential qualification of a broad field for action.

Basin Study and Report of 1936—[This study of the Water Resources Committee is outlined in the paper by Abel Wolman, abstracted in this issue.] Your committee has not yet had opportunity to review the published work.

Coordination—The National Water Resources Committee compiled a list of the federal agencies concerned with water use and control, together with a statement of their function, under date of January 24, 1936. The need for better coordination and unified review of the federal agencies is recognized. As a random example—in one basin, the Public Health Service recommends the drainage of certain swamps as a measure for malaria and mosquito eradication; the Biological Survey asks for an appropriation to enlarge and maintain the swamps as a wild life refuge; and the State Planning Board would turn them into a stream-regulating reservoir.

By a presidential order of May 14, 1936, any agency of the federal government, before making any investigation concerning floods or flood control, shall transmit, in writing, to the National Resources Committee, a specified statement of the proposed work. That committee, in turn, shall advise the federal agency concerned as to what work of similar nature has been, or is being, done by any of the other departments; and a copy of this advice shall be sent to the Director of the Budget. This is an important step in the right direction. Your committee recommends that closer coordination of activities of federal agencies, dealing directly or indirectly with water problems, is essential. A permanent national water-planning unit is needed as an authorized coordinating agency. The membership of this unit should include qualified technical representatives who are not in federal service.

This federal coordinating unit should be vested with such independent authority and personnel that it may freely act as a critical and constructive reviewer of the work recommendations, proposals, or findings of any federal agency relating to water use or control. It should not direct or supervise the construction of works or the details of projects.

The National Resources Committee has successfully and profitably worked in cooperation with the states. In its utilization of the professional services of men not in regular government service, it has shown breadth of viewpoint and freedom from non-progressive and cloistered standardization. It has not, to any material extent, demonstrated any service as critic of the conflicting conclusions or plans of the different federal water agencies. As now authorized and constituted, it may not be qualified to act as such critical agency.

L. K. SHERMAN, *Chairman*

DONALD M. BAKER — LAWRENCE M. LAWSON
M. C. HINDERLIDER — A. D. WESTON

TWO YEAR'S ACCUMULATION OF SILT ALMOST FILLED THIS SOUTH CAROLINA RESERVOIR
Control of Erosion Must Be Considered in a Thoroughgoing Water Resources Policy

Committee on Stresses in Railroad Track

THE COMMITTEE on Stresses in Railroad Track is continuing its work as usual. The small staff of engineers is engaged in field, laboratory, and office work following the program already laid out. During the summer, tests and observations have been made on long stretches of welded rail on the Delaware and Hudson Railroad at Albany and Schenectady, N.Y., and on the Bessemer and Lake Erie Railroad near Pittsburgh, Pa. The observations are being worked up and compared with data taken in a similar way last winter and the previous summer. Various problems relating to rail, rail-joints, and other parts of track have been given attention both through field tests and by laboratory study.

Preparations are being made to undertake rather extensive tests on track next year. As heretofore reported, the research is now being financed by the Association of American Railroads, and reports are being made to the American Railway Engineering Association, the committee in charge being a joint committee with the American Railway Engineering Association.

The members of the committee are Arthur N. Talbot, chairman; W. J. Burton, W. C. Cushing, W. M. Dawley, C. W. Gennett, Jr., H. E. Hale, J. B. Jenkens, George W. Kittredge, Paul M. LaBach, J. de N. Macomb, G. J. Ray, A. F. Reichmann, H. R. Safford, F. E. Turneaure, and J. E. Willoughby. The committee regrets to have to record the loss by death during the year of three valued members who have served since the investigation began 23 years ago—C. G. E. Larsson, John Brunner, and Earl Stimson. Mr. Larsson gave valuable service in the analytical treatment of problems in the early years. Mr. Brunner by his deep interest and thorough grasp of the problems of the investigation continued to be helpful in many ways. Mr. Stimson was closely connected with the work throughout, interested in the projects, and helpful in arranging for facilities for the tests and in interpreting results, and his aid in promoting the administrative side of the investigation was especially valuable. The report was prepared by Chairman Talbot.

Technical and Economic Progress in Sanitary Engineering

FOUR of the papers presented before the Sanitary Engineering Division at the Society's Annual Meeting in January 1937, were of such broad scope as to preclude adequate treatment in "Civil Engineering." Accordingly they are presented here in brief outline only, with the thought that they may later be published more or less in full in "Proceedings."

In the first paper, Mr. Knox discusses the special features of water-softening plants which are not common to filtration plants also. The relative advantages of the lime-soda and the zeolite water-softening processes are compared, and much information is included of practical value to the designing engineer. In each case the cost of the softened water is only slightly greater than the corresponding rate for hard water. In the second paper, Mr. Gascoigne reviews the program of sewage treatment that has been under way in Cleveland since 1912, and describes the current construction at three sites that is now nearing completion. The entire project, including treatment works and intercepting sewers, has involved an expenditure of some $25,000,000, and has been accompanied by valuable experimental work along a number of lines.

What type of sewage treatment is the most economical for a given set of conditions? This intricate problem is attacked by Mr. Schroepfer, who presents the results of an analysis of construction and operating costs for over a hundred plants of various types, and describes a method for comparing their economic merits. He stresses that variations in local conditions make it imperative to study each case individually; however, his method of analysis is flexible and basic.

A simplified technique for stream analysis is presented in Mr. Velz's paper, with a view to the easy determination of sewage-treatment requirements. Among other curves the author has developed a standard reoxygenation curve; a nomograph for converting reoxygenation values from percentages to weights; standard demand curves, giving the relation between biochemical oxygen demand and time, for normal temperature range; and a curve for the prediction of population saturation in terms of years. Only one of these curves is reproduced here.

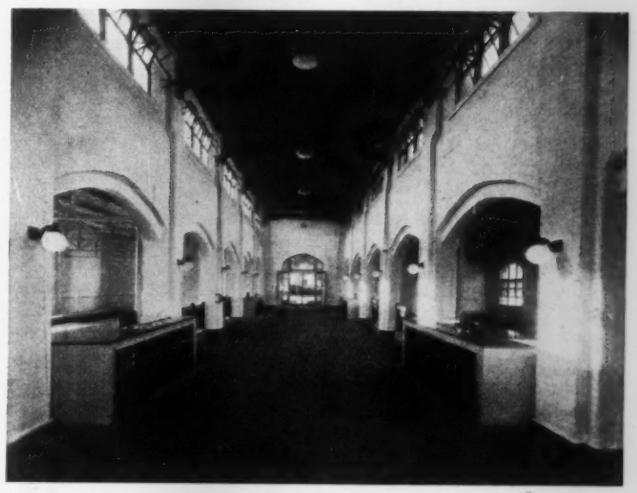
The Design of Water-Softening Plants

OHIO WATER SUPPLIES range in hardness from 60 ppm in the southeastern part of the state to 2,000 ppm in the northwestern part, said W. H. Knox, M. Am. Soc. C.E., assistant engineer of the Ohio Department of Health, in describing special features of water-softening plants not common to filtration plants, before the Sanitary Engineering Division on January 21, 1937, at the Society's Annual Meeting. The first municipal water-softening plant in the United States was installed at Oberlin, Ohio, in 1903. Since 1924 the number of municipal plants has increased rapidly, and when those now under construction are completed there will be a total of 79 in the state. The cost of chemicals for water softening is roughly one cent per thousand gallons for every 100 ppm the hardness is reduced; therefore a well-water supply having a hardness of more than 700 to 800 ppm should not be used.

Aeration is advisable for ground waters if considerable carbon dioxide or sulfur is present; for surface waters it sometimes helps to remove tastes and odors. Patented aerators put on the market in recent years as a substitute for spray nozzles, coke trays, and step aerators, while no more efficient than the non-patented devices, are more sightly, occupy less space, and cause less splash.

In the lime-soda water-softening plant, devices for handling chemicals, applying chemicals to the water, and mixing chemicals with the water are of major importance. Dry-feed machines have almost entirely superseded solution-feed devices in such plants. Quick or flash mixing devices are desirable at very large plants to ensure intimate and thorough mixing of the chemicals with the water. Mechanical mixing devices are preferable to the baffled mixing chambers used in the earlier plants. For these, a detention period of 30 to 40 min is desirable, and in no case should less than 20 min be allowed. For larger plants, clarifiers, which provide for continuous or frequent removal of sludge, should be installed. The coagulation of the water should be practically completed before the water enters the clarifiers so that the clarifiers can act as true settling basins and not have to serve as coagulation basins; for such clarifiers a detention period as short as 2 hours is permissible. At small plants where it may still be desirable to install settling basins without sludge-removal equipment, a detention period of 4 to 6 hours should be provided.

The question of sludge disposal is one of the chief difficulties of the lime-soda process. Where disposal by use of a stream causes unsightly deposits, alternate discharges may be made into lagoons or other impound-



A WATER-SOFTENING AND FILTRATION PLANT AT CEDAR RAPIDS, IOWA
Alcoves in the Operating Gallery Contain the Filters

ing basins, where the sludge is in some cases dried and sold or given to farmers as "agricultural lime." Experimental incineration of sludge is under way in an effort to produce calcium oxide, which may be used again in the water-softening process. All in all, it is evident that some satisfactory means of sludge disposal must be found in the near future.

Recarbonation of lime-softened water is necessary in order to avoid delivering an incrusting water. This is accomplished by applying carbon dioxide, usually in a chamber through which the effluent from the clarifiers passes before reaching the filters. A detention period of 5 to 10 min or even longer is generally provided. It is very essential that the gas passing to the compressor be dry, and the capacity of the device used should not be less than 300 lb of carbon dioxide per million gallons of water treated.

The design of gravity filters for a lime-soda plant involves several special features. Filter influent pipes may be of light-weight steel, but should be oversize, accessible, and capable of quick replacement. The filter sand need not be insoluble in acid, but its removal, regrading, and replacement should be carefully provided for. Pressure filters should not be installed if funds are available for the gravity type, since the water frequently passes through cracks in the filter beds instead of through the media. Pressure filters should never be used where bacterial purification of the water is necessary.

The use of zeolite for municipal water softening is of comparatively recent date, although in Ohio 17 such plants are now completed or in process of construction. Advantages of a zeolite plant over a lime-soda plant include the following: (1) There is no sludge-disposal problem; (2) the first cost is lower; (3) operation is simple; (4) expert supervision of plant is unnecessary; and (5) single pumping from the well to the distribution system is frequently possible. Disadvantages are that (1) zeolite softening alone cannot be used where bacterial purification is required; (2) waters containing objectionable amounts of iron and manganese are not suitable for zeolite treatment unless these minerals have been previously removed; (3) some types of zeolite treatment require a large proportion of wash and rinse water; and (4) zeolite treatment alone provides no pH correction.

Iron removal prior to zeolite softening is essential if the untreated water has an iron content much in excess of 0.5 ppm. This can be accomplished by aeration and filtration. Iron and manganese in solution can also be removed through base exchange by regenerating the zeolite with salt. Zeolite treatment has no effect whatsoever on the pH value, whereas the calcium or incrusting material is removed; as a result, the water may redissolve iron from deposits in the mains or directly from the piping system. These troubles may be eliminated by adjustment of the pH value either through aeration of the water to release the carbon dioxide or by feeding alkali to the water to neutralize it.

For larger plants, gravity zeolite units are superior to the pressure type. In down-flow units the depth of zeolite, where green sand is used, does not usually exceed 3 ft, whereas in the up-flow type the zeolite may be 4 to 6 ft or even more in depth. Since the water from any zeolite unit is of practically zero hardness, hard water must be mixed with it to give the desired degree of hardness for delivery. This may be accomplished by installation of a hard-water by-pass line having either a valve and meter or an automatic proportioning device for control.

A considerable economy can be effected if salt is purchased in bulk instead of in bags. A desirable method of storing salt is to dump it into a water basin equipped with a tight cover. Down-flow units must be backwashed in the same manner as gravity filters, although generally at a lesser rate.

In conclusion, Mr. Knox pointed out that the field for water softening is practically unlimited, and that in Ohio the cost of softened water is only slightly greater than the rates for hard water.

Sewage Treatment at Cleveland

SINCE 1912 the city of Clevland has been developing progressively a comprehensive plan of sewage treatment. The construction program was greatly accelerated in 1931 by the approval of a bond issue totaling $14,000,000 and will culminate during the summer of 1937 with the completion of three large sewage-treatment works—the Easterly, Southerly, and Westerly plants. The entire project, involving an expenditure of approximately $20,000,000 for treatment alone, and $5,000,000 for intercepting sewers, was described by George B.

Aerial Surveys, Inc.

AERIAL VIEW OF CLEVELAND FROM THE WEST
Westerly Sewage Treatment Works in the Foreground

Gascoigne, M. Am. Soc. C.E., Consulting Sanitary Engineer, Cleveland, Ohio.

Considerable experimental work has been carried on to establish with some certainty the accomplishments, cost, and applicability to local conditions of various methods of sewage treatment. This has included the main testing station work (1912), the fine-screen demonstration plant (1916), activated sludge tests (1916–1917), demonstration work at the Westerly Plant (1932–1933), and many other tests and studies relating to the mechanical destruction of organic matter in sewage and the recovery of by-products.

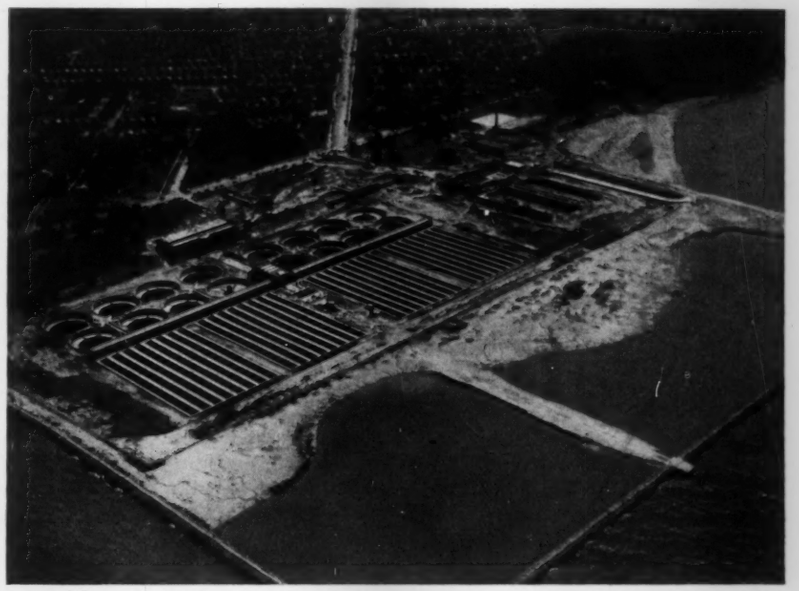
From this experimental work it has been concluded among other things, that organic matter can be stabilized most economically by biochemical action; that there is little merit in the idea of recovering grease from sewage on a commercial basis; and that gas may now be considered a worth-while by-product.

GENERAL FEATURES OF DESIGN

Cleveland has a combined system of sewerage, with intercepting sewers in the various districts leading to each of the three plants. In general, preliminary treat-

ment will be provided for two and one-half times the dry-weather flow, and complete treatment, where necessary, will be provided for one and one-half times the dry-weather flow. The suspended matter content of the sewage discharged at the three plants ranges from 200 to 270 ppm, and the sewage flow per capita varies between 110 and 160 gal daily.

The Easterly Sewage Works is of the presettling, activated-sludge type. It is located on the lake front, and is designed to serve 770,000 persons, with provision for ultimate expansion to serve 1,000,000 persons. It provides for the comminution of the coarser floating material; the removal of grit; release of the grease by air agitation and skimming; pre-settling; aeration of the settled sewage in spiral-flow tanks; and settling of the mixed liquor. The aeration and final settling equipment can be operated as one combined plant, or subdivided into four separate plants, each complete in itself.



Aerial Surveys, Inc.

EASTERLY SEWAGE WORKS, LARGEST OF THE THREE PLANTS SERVING CLEVELAND

Of special interest at the Easterly Plant are the comminutors, which will screen the sewage through $^3/_8$-in. slots and shred the screenings under water. The screenings will then pass through with the sewage to the other treatment devices. Another feature is the grease catchers. These are channels, provided with diffuser-plate aeration, and designed to retain and agitate the sewage from 4 to 6 minutes. From them the sewage will flow to the pre-settling tanks, where grease liberated by the agitation will be skimmed mechanically during the longer quiescent flow. Skimmings will be combined with the sludge for subsequent treatment.

To safeguard against odors, buildings or covers have been provided over all the treatment devices, except the aeration tanks and the sludge-settling tanks. Chlorinating equipment is also to be installed.

The Southerly Sewage Works is located at an inland site; its effluent discharges into the Cuyahoga River. The original plant, built in 1926–1928, consists of Imhoff tanks and trickling filters, and was designed to serve 240,000 persons.

Construction now in progress at this site interpolates aeration and settling equipment between the Imhoff tanks and the filters. Sludge gas will be used to operate the blower engines. The distribution piping for the trickling filters is being changed to permit larger dosages, and magnetite filters will replace the original humus tanks. These several measures will increase the over-all plant capacity by some 50 per cent, and should minimize the possibility of objectionable odors about the trickling filters.

The sludge disposal works at the southerly site will handle the sludge from both the Southerly and the Easterly plants, that from the latter being pumped to the treatment point through 13 miles of 12-in. force main. Three-stage centrifugal pumps will be used. The sludge will consist of a mixture of pre-settling tank sludge, excess activated sludge, and grease or tank skimmings.

The sludge disposal works will include concentration tanks, heated digestion tanks with floating covers, vacuum filters, incinerators, and a disposal area for sludge ash. The piping arrangement will permit the use of any desired combination of tanks for the separate or the combined operations of primary digestion, secondary digestion, and storage. Also, it will be possible to vary the number of tanks for any given function and so to meet the condition of peak loading. The vacuum filters and the incinerators will be located in a single building, and connected by belt conveyors. Over-all incinerator capacity will be 400 tons of filter cake daily.

The Westerly Sewage Works is another lake front plant, and is designed to serve 240,000 persons with an additional industrial organic load having a population

Aerial Surveys, Inc.

THE SOUTHERLY SEWAGE WORKS AT CLEVELAND

Note Honeycomb Arrangement of Hexagonal Sludge-Digestion Tanks at Left

equivalent of 90,000 persons. The original plant, placed in operation in 1922, consisted of bar gratings, grit chambers, two-story settling tanks, and disinfection equipment for use during the bathing season. The effluent and the digested sludge are discharged through a submerged outfall in 30 ft of water 3,000 ft offshore.

Recent developments at this site include the provision of separate sludge-digestion tanks with floating covers, which are designed to supplement the digestion capacity of the original Imhoff tanks. Also, there is being provided a sludge-filter incinerator installation with a capacity of 100 tons daily of wet filter cake.

COST OF PROJECT

All the sewage works of Cleveland have been built under contracts awarded after competitive bidding; and except for such items as buildings and equipment, the contracts have been on the basis of unit prices. The policy has been to make major or general contracts for an integral part of the plant, and inclusive of all trades and of the smaller contained equipment. Specifications for equipment have generally been open, with details rigid enough to assure adherence to set standards. In cases where it has been desirable to restrict equipment to certain makes, it has been the practice to obtain protective quotations from the manufacturers prior to any commitment in the designs. It is reported that these quotations have in all instances been closely adhered to.

Engineering on the original works at the easterly and westerly sites was performed wholly by the city's organization. However, since 1924 the work has been designed and its construction supervised by the offices of Mr. Gascoigne. The city handles the surveying and detailed inspection; subsoil borings and soundings are made by contract; and materials are tested either by private firms or by the city in its own laboratory. This coordination of several engineering agencies has proved workable and economical. The dominant central authority necessary to the success of such a plan is Robert Hoffmann, Hon. M. Am. Soc. C.E., the city's consulting engineer.

Economics of Sewage Treatment

IT WAS the aim of the paper by George J. Schroepfer, Assoc. M. Am. Soc. C.E., Assistant Chief Engineer, Minneapolis–St. Paul Sanitary District, to show in a general way the economic relationship between the various methods of sewage treatment, and between the several processes involved in a particular method. The question of precisely what degree of treatment should be adopted in any particular case was viewed as beyond the scope of the paper, attention being centered on the problems that arise after that basic consideration has been determined.

The author took up in succession (1) screens and grit chambers, (2) sedimentation, (3) trickling filters, (4) activated sludge process, (5) chemical treatment, and (6) effluent filters. The economic analyses were based on cost and operating data from plants in all parts of the country. From a cost standpoint, the various processes were compared on the basis of the total annual charges per million gallons of sewage treated per 1 per cent reduction in either suspended solids or B.O.D. This "yardstick" does not take into consideration the fact that the cost per unit of reduction increases with the degree of treatment, nor does it definitely show the effect of plant size on cost per unit of reduction. With these exceptions, however, he believes it to be proper and correct; and when cognizance is taken of the effect of these factors, the method should present a true picture of the economic relationship of the various processes of treatment.

AERATION TANK AT EASTERLY SEWAGE TREATMENT PLANT, CLEVELAND, OHIO

For each of the six processes investigated, curves were presented showing the construction cost and total annual operating charges as functions of plant capacity. Other curves showed the reductions in suspended solids and B.O.D. as functions of other pertinent variables (Table I).

TABLE I. PRINCIPAL RELATIONSHIPS SELECTED FOR GRAPHICAL PRESENTATION IN STUDY OF SEWAGE TREATMENT ECONOMICS
Column Headings Are Ordinates; Table Entries Are Abscissae

PROCESS OR TYPE OF PLANT	REDUCTION, SUSP. SOLIDS		REDUCTION, 5-DAY B.O.D.	
	Per Cent	Ppm	Per Cent	Ppm
Screens and grit chambers	Screen opening	....	....	....
Sedimentation	Hours detention	....	Hours detention	....
Trickling filters	....	S.S. raw sewage	....	B.O.D. raw sewage
Activated sludge	....	S.S. raw sewage	Hours aeration	B.O.D. raw sewage
Chemical treatment	Cost chemicals per mgd	....	Cost chemicals per mgd	....
Effluent filters	....	Load, ppm of s.s. for various types of treatment	....	....

Although not productive of as high removals as other units of the treatment plant, screens and grit chambers are none the less important. They make for efficient and economical operation of the rest of the plant, especially if the sewage is from a combined system. With screens with 1-in. clear openings and grit chambers of proper dimensions, it is reasonable to expect a total removal of about 7 cu ft per million gal.

The amount of reduction accomplished by sedimentation is influenced by such factors as the viscosity of the liquid and the specific gravity and degree of coagulation of the solids. However, for a particular sewage, one of the most important factors is the detention period. On the basis of B.O.D. reduction, the economical period of settling (for a sewage of average characteristics) is 3 to $3\frac{1}{2}$ hours, while on the basis of reduction in suspended solids, it is $1\frac{1}{4}$ to $1\frac{1}{2}$ hours. (This applies to plants where sedimentation is the sole process of treatment, and not to those in which it is followed by secondary processes.) High reductions in B.O.D. can usually be more economically secured in other ways.

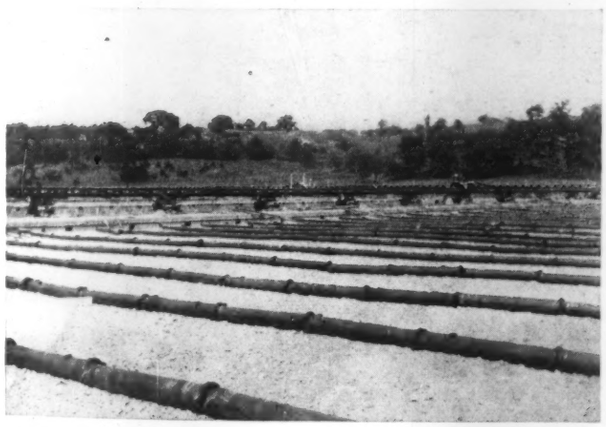
The average over-all reduction accomplished by the

trickling-filter plants investigated was 85 per cent in 5-day B.O.D. and 84 per cent in suspended solids. This percentage reduction is, within limits, independent of the strength of the sewage applied to the filters, and of the rate of application; it is therefore difficult to select the "most economical" loading. Trickling filter plants are now being operated experimentally at rates as high as 25 mgd per acre. If it is demonstrated that such high sustained rates are practicable, trickling filters will be in a most advantageous position as far as the economics of treatment is concerned.

Cost estimates to determine the economical balance between sedimentation and secondary processes in trickling filter plants indicated that the most economical period of sedimentation is the shortest one. However, there is a practical limit to the shortening of the period, and it appears that a detention of about $1^1/_2$ hours in preliminary tanks is desirable for ordinary sewage.

Activated sludge plants (including preliminary treatment) were found to accomplish an average reduction of 92.5 per cent in 5-day B.O.D. and 91.0 per cent in suspended solids. The most economical period of aeration for normal sewage is calculated to be about $4^1/_2$ hours. As in the case of trickling filters, the most economical period of sedimentation is the shortest one; practical considerations, however, demand a period of one-half to one hour. The loading of final settling tanks following aeration averaged about 900 gal of sewage flow (not including return sludge) per sq ft per day. The rate selected should be based on a consideration of variations in flow and on the depth of tank, shallow tanks requiring lower rates of application.

One of the features of chemical treatment is its susceptibility to variation in the amount of reduction by varying the amount of chemicals used. The difference in effectiveness of chemical treatment at various plants suggests the desirability of careful investigation before selecting this type of plant for a particular case.



TRICKLING FILTER UNDER CÓNSTRUCTION AT CLEVELAND, OHIO

In the last several years, a number of effluent filters have been built consisting of beds of magnetite sand cleaned by the action of a solenoid. Experimental data are also available on modified rapid sand filter beds, as well as on sand beds cleaned by jets of water. None of these types can at present be considered as a basic method of treatment; their important application is in conjunction with other processes. The reductions accomplished by them are a function of the strength of filter influent and of the type of basic treatment to which it has previously been subjected.

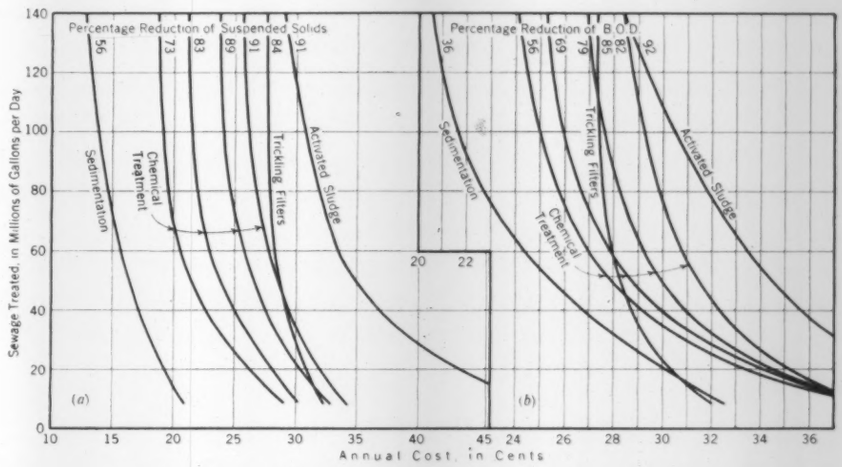


FIG. 1. TOTAL ANNUAL CHARGES OF VARIOUS METHODS OF TREATMENT PER MILLION GALLONS OF SEWAGE TREATED
(*a*) Per 1 Per Cent Reduction in Suspended Solids; (*b*) per 1 Per Cent Reduction in 5-Day B.O.D.

Estimated total annual costs of treatment per million gallons of sewage per 1 per cent reduction in suspended solids and B.O.D. are summarized in Fig. 1 for a sewage of normal strength and characteristics. This analysis is based on construction costs of the general level prevailing from 1923 to 1930, and on fixed charges of 6 per cent.

In summing up, Mr. Schroepfer stressed again the importance of considering all factors that might have a bearing on the economics in any particular case. Among these are (1) the degree of treatment capable of accomplishment by the various processes, (2) the actual commodity costs and rate of fixed charges at the time of construction, (3) characteristics of the sewage, (4) seasonal variations in degree of treatment, and (5) amount of hydraulic head available. He concluded his paper with a brief discussion of the application of his analysis to preliminary investigations of the Minneapolis–St. Paul sewage disposal project.

Deoxygenation and Reoxygenation

ALL TOO FREQUENTLY sewage disposal is thought of as synonymous with discharge into the nearest body of water. Such, however, is not the case. Speaking before the Sanitary Engineering Division, on January 21, 1937, Clarence J. Velz, Assoc. M. Am. Soc. C.E., pointed out that ultimate disposal, or final oxygen equilibrium, is inescapable, and if not accomplished wholly or in part before discharge, becomes a stream liability.

The public is fast becoming impressed with the fact that it must be concerned with this problem beyond the sewer outlets and that something must be done about the menace and nuisance of stream pollution. A sound and economical solution requires an evaluation of pollution liabilities and stream assets, in advance of sewage treatment, to permit the determination of the effect upon the stream of any proposed remedial program.

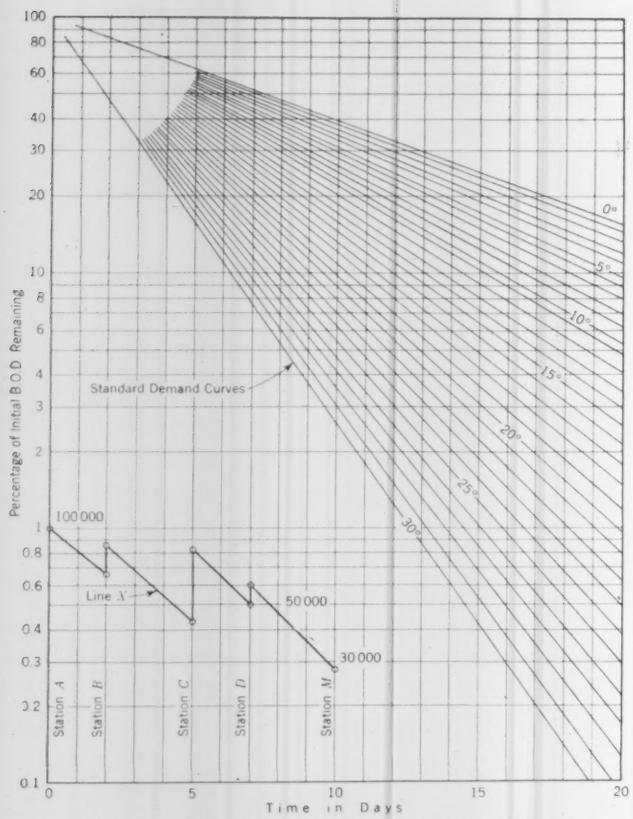


FIG. 1. STANDARD DEMAND CURVES, GIVING RELATION BETWEEN BIOCHEMICAL OXYGEN DEMAND AND TIME

Nuisance in streams is a combination of complex noxious conditions. Though no single measure fully reflects all those conditions, the oxygen content of the stream is the most inclusive and the best single index of the degree of pollution. Deoxygenation is a complex biochemical process influenced radically by time, temperature, and nature of waste. Reoxygenation, no less complex, is primarily a chemical process influenced radically by concentration of dissolved oxygen, time, temperature, depth, and turnover.

In their formula for oxygen sag, Phelps and Streeter have integrated both the deoxygenation liabilities and the reoxygenation assets, and defined all the factors influencing the rates of change in each by coefficients of deoxygenation and of reoxygenation. Such an integrated equation has many advantages, but in certain instances a better understanding and wider application of the fundamentals can be obtained by considering deoxygenation and reoxygenation separately.

The most important asset of a stream is the natural process of reoxygenation, that is, absorption of oxygen from the atmosphere. Without it, we would long ago have been faced with universal complete treatment or disposal in deep sea. Fortunately, reoxygenation is a gift of nature. It is important in the pollution problem that this natural asset be evaluated, for economics demand that we use it wisely.

The separate evaluation of reoxygenation as deduced by Phelps has advantages over the integrated oxygen sag formula in that it permits direct evaluation of the particular physical factors of each stream, including the dominating factor of stream depth. Furthermore, the separate evaluation permits application, not only to inland streams and lakes, but also to brackish waters where the complexities of tidal flow preclude the use of the oxygen sag formula.

The question arises, if this formula has these advantages, why has it not been more universally applied? The answer is that the mathematics is too involved. Consequently, Mr. Velz has developed a simple, rapid solution by graphical methods.

The major pollution liability in streams is deoxygenation resulting from the satisfaction of the natural oxygen demand of organic waste matter. In the expression of his law, "The rate of biochemical oxidation of organic matter is proportional to the remaining concentration of unoxidized substance measured in terms of oxidizability," Phelps changed the concept of pollution from that of a simple, static, chemical dilution phenomenon to one of changing biochemical complexity.

The technical literature of the past ten years is prolific of discussion of the fundamentals of biochemical oxidation, but the application of these fundamentals is not so widely employed. A convenient graphical representation of the well known time–temperature functions may be prepared. By plotting the log of oxygen demand expressed as percentage of total initial demand against time for rates at various temperatures, a nest of standard demand curves (Fig. 1) is obtained.

An example of the use of these curves is indicated by the line X on the diagram. This is developed as follows: In a stream stretch through Stations A, B, C, and D to its mouth M, the oxygen demand remaining unsatisfied is obtained by starting at Station A with a pollutional load of 100,000 population, a temperature between Stations A and B averaging 18 C, a time of passage of 2 days; and extending the line from A to B at the proper slope for a temperature of 18 C. This gives a residual at Station B of approximately 66,000. At Station B an additional load of 20,000 is contributed, making a total at B of 86,000. The temperature between B and C averages 20 C, and the time of passage is 3 days. Extending the line from B to C at the proper slope for a temperature of 20 C gives a residual at C of approximately 42,000. By continuing in this way, and integrating to the mouth of the stream, the net residual demand is obtained.

With the logarithmic slopes of the standard demand curves, and with the distance between stations expressed in time of passage, the temperature of the water and the quantities of pollution contributed at each station (expressed in any convenient term, such as population equivalents) known, it is a simple graphical operation to integrate the resultant demand and determine the relative responsibility of polluters at any location on the stream.

Variation in stream flow is a paramount factor in oxygen balance by virtue of its influence on volume and, more important, on the element of time in deoxygenation and reoxygenation. Uncontrollable disturbance of equilibrium in nature's oxygen balance is almost entirely associated with variations in the rate of stream flow.

While any particular oxygen-balance profile is possible of reasonably exact determination from the fundamental laws governing deoxygenation and reoxygenation, Mr. Velz points out that load factors and runoff probabilities are not definitely predictable. However, by computing a series of oxygen-balance profiles over a range of loads and runoff, accurate limits of stream conditions are obtained. Obviously, these defined limits afford a foundation work from which to measure the necessity and effectiveness of any scheme of treatment plants designed to relieve the stream of portions of the pollution load. The subjection of various remedial combinations to such evaluation insures the proper protection to the stream and to the taxpayer.

Surge in Water and Sewer Tunnels

Possibility of Its Occurrence Must Be Carefully Investigated, Especially in Large Installations

By ARTHUR B. MORRILL, M. AM. SOC. C.E.
and HARRY KALLGREN

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SURGE investigations are more or less routine in the design of hydroelectric plants; they are far less common in the design of sanitary engineering works. Nevertheless there are cases, especially in the larger installations, where the effect of surge must be carefully studied. Messrs. Morrill and Kallgren open the present article with a specific example illustrating the importance of the problem. Next they outline several possible methods of protection against surge —by-passes, tanks, and so forth—pointing out the advantages and limitations of each. Their paper closes with a description of the surge problem arising in the design of the ten-mile-long intercepting sewer now under construction at Detroit. Model studies were undertaken as a guide in the planning of protective works. This material is abstracted from a paper presented before the technical session of the Sanitary Engineering Division on January 21, 1937, at the Society's Annual Meeting in New York.

SURGE is only occasionally an important factor in sanitary engineering designs, but there are cases where it may require careful consideration. For example, at the Water Works Park plant of the Detroit department of water supply, the low-lift pumping station is located approximately 3,770 ft from the old intake crib in the Detroit River. The ordinary hydraulic grade in the screen room was formerly about 20 ft below the ground surface, or 10 ft below the river level at the intake. The pump room is separated from the screen room by a division wall, containing a door whose sill is 1 ft above ground level. Nevertheless, surges have risen high enough to flow through the door. Damage to the motors is prevented by arranging the door to act like a check valve. The screen room acts as a simple surge chamber, and the surge overflows through scuppers placed in the side of the building just above the ground surface.

Surge occurs usually from the sudden starting or, particularly, from the sudden stopping of pumps connected to long pipe lines When pumps are driven electrically, the possibility must generally be considered that the electric power will fail, and all the pumps will stop simultaneously. Duplicate power lines are of little importance in preventing surge, as the peak of the surge will ordinarily be reached within a few minutes after the power fails. Attempts to restart a pump while a surge is in progress may easily make the rise more extreme instead of damping it.

Surge in sewerage or water supply lines usually occurs on the suction side of pumping stations. On the discharge side, the water often flows directly to a nearby treatment plant with a large free water surface, so that the sudden change in the rate of pumping results only in a temporary raising or lowering of that surface. When pumps discharge directly into pipe lines under pressure, their sudden starting or stopping may result in water hammer. Although this problem is similar to surge, it is not discussed in this paper.

On the suction side there are two possible conditions: (1) The conduit supplying the pumps may be running only partly full. In this case the surge problem is often so unimportant as not to require any special attention; under unusual conditions, however, troublesome surge waves may be set up in the conduit. (2) The conduit supplying the pumps may be running under pressure. Even with sewers designed to run less than full, the possibility of this condition must generally be considered.

Surge is a function of the kinetic energy of the water in the conduit supplying the station. In a closed conduit with practically rigid masonry walls, the surge energy is principally dispelled at free surfaces, as in the pumping station suction well or some special surge chamber. Since the kinetic energy depends on the mass of the moving water and the square of its velocity, surge effects are most serious in long closed conduits, or in shorter conduits operating at unusually high velocity. In sanitary engineering design, high-water velocities are unusual, but the length of closed conduit may be very great. Thus, although velocity may be moderate, the amount of kinetic energy may be enormous.

Surge difficulties are more apt to arise with designs of the largest plants than with those of average or small size. One reason is that the larger the conduit, the higher the velocity is likely to be. Another reason is that the free water surface in small pumping stations is usually larger in proportion to the pumping capacity than in large stations. A suction well in a small plant is often adequate to serve as a surge chamber, while that of a very large pumping station may be so small in relation to the flow as to have practically no effect in damping surge.

In a sewer, problems arise that are not encountered in a water supply system. The rise of surge must be kept down to an elevation low enough to avoid blowing manhole covers and flooding streets. This, of course, should be guarded against in the design of the system.

SURGE RELIEF METHODS

Several methods are available for providing surge relief. They are discussed briefly in the following paragraphs.

Overflow to Pump Discharge—When the flow in the conduit is being produced by pumps drawing from it, it is often possible to protect against surge by providing an overflow by-pass from the suction well to the pump discharge channel or chamber. This by-pass should be equipped with a weir slightly higher than the maximum water level in the basin, to prevent backflow to the suction well under ordinary conditions.

There will ordinarily be ample room in the sedimentation basin to receive the overflow, as outflow from the basin will continue with little reduction after the pumps stop, and the total quantity of water entering the basin during the first half cycle of the surge will be less than if the power failure had not occurred. Subsequent rises of the surge will discharge still smaller quantities.

Where this method of surge relief can be used it is likely to be the cheapest and best. It also has sanitary advantages. In a sewerage system the occasional over-

flow of a large quantity of sewage in an unusual place is likely to be objectionable or even dangerous. In a water system, the only alternative to the by-pass may be a connection to a sewer or polluted stream, and this is out of the question unless all possibility of backflow can be avoided.

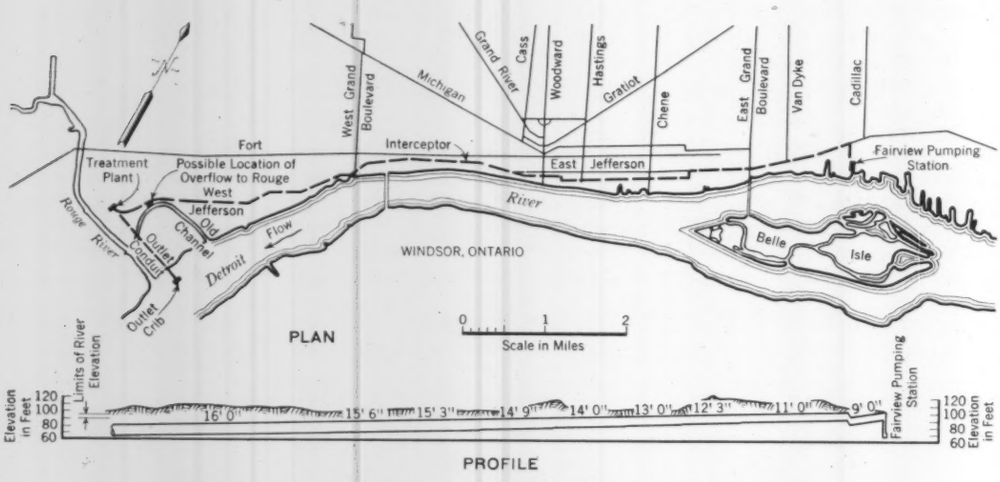


FIG. 1. PLAN AND PROFILE OF THE DETROIT SEWAGE INTERCEPTOR

The by-pass design requires that, at the peak of the surge, the water level in the suction well should rise higher than the ordinary discharge water level. This requirement sometimes is not objectionable. If, however, the supply conduit is a sewer vented to the surface through manholes, the plan may not be suitable, as the necessary rise in the hydraulic gradient of the sewer near the pumping station may cause sewage to flow out of the manholes into the streets.

Overflow to Waste—A second method of surge relief is to arrange structures so that the surge water can overflow harmlessly to waste. This plan may involve sanitary difficulties, as previously mentioned, but if the pumping station is reasonably close to some body of water, and at a reasonable elevation above it, the plan may be satisfactory. In the nature of the case, however, sewage pumping stations are apt to be located only a few feet above the maximum water level in the nearby river or lake. Here the level to which surge can be allowed to rise is closely fixed. Some type of weir outlet will be necessary, with the crest slightly above the maximum water surface in the stream. The hydraulic gradient during surges must rise higher than this crest, yet not higher than the ground surface at the manholes along the sewer.

In general, the lower a surge overflow weir is placed, the greater will be its discharge. This second method has, ordinarily, a lower weir than the first, and the resulting rate of discharge may be so great as to make the necessary structures expensive.

Since a sewage interceptor is likely to follow natural watercourses, there may be intermediate points along it where surge relief can be provided. This does not usually, however, eliminate the need for a certain amount of surge protection at the pumping plant itself.

Surge Tanks—The simplest surge tank is a riser, of the same diameter as the supply conduit, and connected to it near the lower end of the line. Conditions are not unusual, however, which would produce a rise of 100 or 200 ft in such tanks; hence they would be uneconomical.

The most obvious modification of the simple idea is to make the plan area of the surge tank larger than the cross-section of the conduit and riser. If the average elevation of the contents of the reservoir is lower than in the standpipe, the necessary volume will be greater in order to absorb the same amount of kinetic energy. Nevertheless, a shallow reservoir on the surface of the ground will ordinarily be cheaper than an equivalent standpipe.

The next modification is to extend the inlet riser to near the top of the tank. Thus more work is done by the surge in filling the tank, as all the water must be raised to the top. The top edge of the riser shaft serves as a weir. Where a high surge gradient may cause sewage to flow out of manhole tops, the length of this weir will be important; the maximum head on the weir, added to the elevation of the weir crest, must not exceed the maximum allowable elevation of the hydraulic gradient in the conduit. So it may be necessary to flare the top of the riser to a weir of much larger circumference, or perhaps to terminate the riser at the tank floor and surround it by a weir wall of the desired length.

If the surge riser extends above the floor of the tank, the latter will naturally not drain of itself. Sometimes an independent drain into a nearby sewer is provided, and sometimes the problem is solved by making openings through the wall of the riser just above the floor of the surge tank. On account of their small size it is still necessary for most of the inflowing water to rise and flow over the weir into the tank, but they are sufficient to drain off all the contents slowly after the surge.

Surge Relief Conduit—A fourth method of providing for surge is to construct a conduit or channel from the place where it will develop, to some convenient discharge point, as in a river. If the distance is short and the available fall is large, this method may be a good one, although calculation of the hydraulics of the relief conduit is difficult at best.

A surge relief conduit is here understood to mean one of such capacity as to carry away the water about as fast as it arrives, with little or no dependence on storage. Drains in surge tanks act to some extent as surge relief conduits, but there the principal reliance is placed on the storage effect of the tank.

If the system is large, the necessary length of conduit considerable, and the available fall small, then this method is likely to be impracticable. A large relief conduit is necessary, and in order to make use of the full available head it must be located largely below the level of the water into which it is to discharge. Backwater gates or a weir chamber must be provided to keep the river water from flowing into the pumping station under ordinary conditions.

If such a surge conduit has a backwater gate at the discharge end, it will ordinarily stand empty, any water from previous surges having drained back into the suction conduit or pump suction well. When a surge occurs the first effect is to fill the surge conduit, so that the structure acts at first as a storage reservoir. It will ordinarily be found that this effect can be more economi-

cally obtained in a typical reservoir structure than in a long conduit of the same volume.

As soon as the conduit is filled and the level behind the backwater gate rises above the river level, the gate starts to open and the water in the conduit begins to move. What takes place at this time is not easy to calculate. Surge is rising at the pumping station at a certain rate, and the velocity in the conduit, originally zero at the backwater gate, is accelerating. It is necessary to determine how much time will be taken for the necessary acceleration, and whether the surge at the pumping station will rise above the allowable limit before a sufficient velocity is produced in the conduit. These questions can doubtless be solved by careful calculation or model experiment, but approximate calculation will often show that another plan is preferable.

General Methods—In a long system where the kinetic energy is great, surge can often be handled best by means of a combination of lift, overflow, and storage. It is sometimes possible to so design the pumping station that the weir is inside the station itself, but often the cost prohibits such an arrangement. In the case of large sewers where the allowable height of surge is small, the most satisfactory method seems to be to give the water a free "getaway" over a weir to a basin, river, or lake. Inasmuch as surge occurs infrequently, mechanical devices such as backwater gates, which require maintenance, should be avoided if possible. To set in motion a body of water that is at rest is also objectionable.

The cost of provision for surge should be kept as low as possible, as it is merely insurance against damage to the structure and equipment. However, surge provision is fully as important as any other link in the system when it is considered what any shutdown, even for a short period of time, may mean to manufacturing concerns and private homes.

THE DETROIT SEWERAGE SYSTEM

The sewage disposal project now under construction in Detroit includes an intercepting sewer (Fig. 1) some 50,000 ft in length, paralleling the Detroit River, with a diameter varying from 9 ft at the upper end to 16 ft at the plant site. This interceptor diverts the dry-weather flow of many existing sewers along the way. It is designed for a flow of 1,230 cu ft per sec. This represents a mass of 251,000 tons of water, with a velocity varying from 5.1 to 7.28 ft per sec, which must be stopped in case of a power failure. The hydraulic gradient, at maximum discharge, will be from El. 99.0 to 81.0, or a drop of 18 ft. The lowest manhole along the interceptor is near the lower end, and its top is at El. 102.0. This point limits the height to which the surge may rise.

The kinetic energy at the plant site of a flow of 1,230 cu ft per sec is figured to be 294,000,000 ft-lb, using $\alpha = 1.2$ in the formula, $KE = \alpha mv^2/2$. The factor α is introduced to make allowance for the variation in velocity over the cross-section of the pipe—a condition which makes the total kinetic energy from 10 to 20 per cent greater than it would be if the velocity at every point were equal to the average.

For economical reasons the suction well of the pumping station is designed as small as possible, with the result that the surge must be taken up outside the station. If it were practical to dissipate this amount of energy with a plain surge tank 16 ft in diameter, a tank 217 ft in height above the crown of the interceptor, or over 190 ft above the ground, would be required.

Several possible solutions were considered. The first thought was to spill the surge over a weir placed at such a height as to keep the crest of the hydraulic gradient low enough to save the motors from any possible damage, and then carry the water through a conduit to the Rouge River, which is 1,380 ft away. In order to do this, the conduit should probably be the same size as the interceptor, and should be kept empty to provide a quick getaway. This would require backwater gates at the Rouge River, which would be objectionable because of the danger of freezing. It would be impracticable to keep the conduit full, for at high river stages the available head would be insufficient to accelerate the quiet water in the required period of time.

A second possibility was a plain storage reservoir—a square, covered basin placed over the interceptor in front of the pumping station, and fed by a riser of the same area as the interceptor. The maximum allowable surge gradient was set at El. 102.0 and the weir surrounding the riser was set at El. 100.0. This is one foot higher than the maximum normal elevation of the hydraulic gradient at the upper end of the interceptor, over ten miles away. Openings through the weir wall around the riser, near the bottom of the basin, would drain the water back into the interceptor when the pumps were started again.

One disadvantage of such a basin was the large area it required. The space was available; still the development of the sewerage system might in the future require the space for expansion, and for this reason it was considered advisable to make the surge structures as small as possible.

It seemed that some advantage should be taken of the fact that the interceptor at one point came within 50 ft of the Rouge River. This point, however, is 3,000 ft from the pumping station. The question then came up, how much of the kinetic energy in the interceptor would be dissipated by an overflow weir at that point, and how much would "slip past" to the pumping station. This was beyond calculation, and even assuming the weir to be 100 per cent effective, the kinetic energy in the 3,000-ft length of interceptor below the overflow point would remain to be taken up at the pumping station, probably with a smaller surge basin.

MODEL INVESTIGATION OF DETROIT INTERCEPTOR

It was decided that a small model was the best method of solution. Arrangements were made by the Detroit department of public works with George Hubbell, instructor in civil engineering at Wayne University, to conduct this work. The specific points to be determined were the effects on the volume and the rate of spill at the plant of a relief overflow in the line, and the effect on the rate of spill at the relief of a varying gradient at that point. Construction and testing of the model required but three weeks.

The actual interceptor consists of several sections of tunnel of different diameter, but as no attempt was to be made to secure data at any points except the pumping station and the proposed overflow point, it was not considered necessary to model accurately all the variations in tunnel diameter with discharge increasing gradually towards the lower end. The model design was based on an "equivalent interceptor," of uniform diameter, having the same length, fall, and total kinetic energy as the actual tunnel of varying diameter. This equivalent interceptor has a diameter of 15.2 ft, a velocity of 5.25 ft per sec, and a discharge of 952 cu ft per sec.

In conducting surge model tests the calculation of scale ratios is very important. It is not usually possible or even desirable, to make the scale ratio for length of conduit, diameter of conduit, velocity, and diameter of surge tank the same. Ratios must be adopted to give

the necessary precision and still keep cost and space requirements at a minimum. When the basic ratios have been selected, all other ratios, such as those for vertical heights, discharges, time, and weir head, can be calculated.

A length of 50 ft of 2-in. copper pipe with streamline fittings was chosen to simulate the interceptor. This gives a length ratio of 1:1,006 and a diameter ratio of 1:91.2. The numerous other ratios were calculated between certain values for the prototype and the same values for the model.

In interpreting the results, it was assumed that the volume of spill, being a function of work, is obtained directly from the model, but that the maximum true rate of spill, being a function of the designed rate in the interceptor, is obtained by multiplying the calculated rate of spill for the prototype by 1.295—that is, the ratio of the discharge capacity of the actual interceptor to the discharge capacity of the equivalent interceptor.

As a check on the performance of the model, a preliminary test was run, simulating a simple surge condition that was also analyzed mathematically. The correspondence was good.

From the model, it was found that the volume of spill at the plant and the maximum rate of spill at the point 3,000 ft from the plant are independent of the diameter of the surge riser as long as the velocity head in the latter is less than about 0.5 ft.

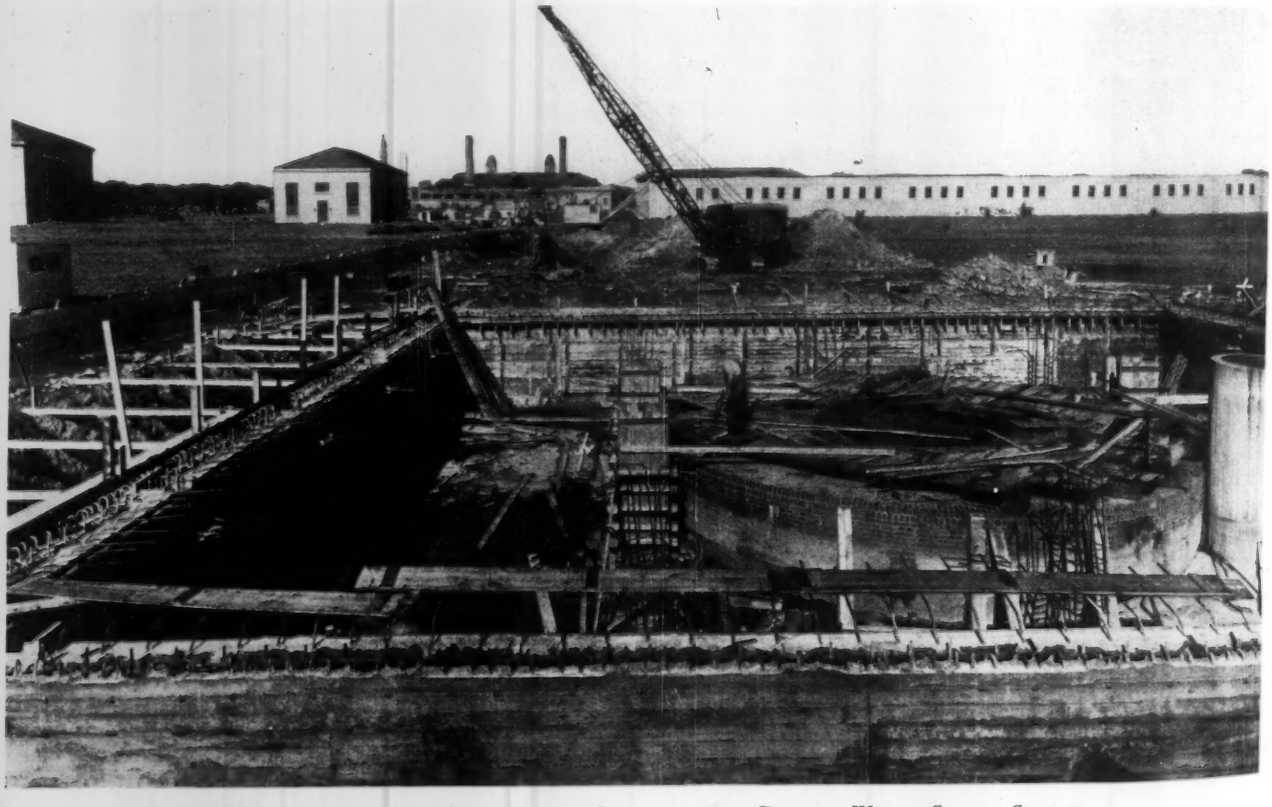
With the spilling weir set at El. 97.0, and the surge basin weir at the plant fixed at El. 100.0, the actual spill at the plant was calculated from the model measurement to be 47,000 cu ft. The theoretical kinetic energy for the intermediate 3,000 ft is 26,300,000 ft-lb, using $\alpha = 1.2$ and $V = 6.12$ ft per sec. The kinetic energy for the actual spill of 47,000 cu ft is 59,500,000 ft-lb. This means that 33,200,000 ft-lb, or 12.4 per cent of the energy above the overflow point, slipped past that point. The percentage changes greatly on varying the elevations of the two spills. For instance, with the overflow weir at El. 98.0, 33 per cent of the kinetic energy slipped past this point. No rational way was found to calculate the percentage of the total kinetic energy which slipped past the overflow connection.

As a result of the investigation it was found that if a single surge basin were installed at the lower end, designed to spill water over a weir placed at El. 100.0, it would have to have a capacity of 244,000 cu ft. Such a basin would be 158 ft square and 11 ft 6 in. deep.

If an overflow weir 3,000 ft above the lower end of the interceptor were used, in conjunction with a surge basin at the plant, the spill at the plant would be only 44,000 cu ft, and the rate of spill at the overflow weir 882 cu ft per sec. This is based on placing the elevation of the weir in the basin at El. 100.0 and the overflow weir at El. 96.375. The required basin would be 69 ft square and 11 ft 6 in. deep, and the length of weir in the overflow structure, 83 ft 6 in. This appears to be more economical than the one large basin.

REFERENCES

An article entitled "Model and Full Size Surge Tests on Large Branched Tunnel System of Detroit Water Supply," by Arthur C. Michael, in the *Journal of the American Water Works Association* for March 1936, gives a list of 30 references to articles and texts on various phases of the surge problem.



PROTECTION AGAINST SURGE ON THE INTAKE OF THE DETROIT WATER SUPPLY SYSTEM
A 72 by 72-Ft Surge Basin Under Construction

Sewer Maintenance an Engineering Problem

Systematic Inspection and Repair Is as Necessary for Sewers as for Other Structures

By RAYMOND R. RIBAL

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OFFICE ENGINEER, CITY OF OAKLAND, CALIF.

WHILE the need for maintenance of buildings and highways is always apparent, a sewer is too often forgotten as soon as the trench is backfilled, and it is not again brought to mind until trouble occurs. Maintenance of sewers is distinctly an engineering problem. This was proved during the author's recent survey of maintenance practice in eight California cities, as a result of which some valuable conclusions as to good practice have been drawn. The following article is abstracted from Mr. Ribal's paper delivered on January 21, 1937, before the Sanitary Engineering Division at the Annual Meeting of the Society.

IN the closing months of 1932, it was my privilege to determine what savings could be made in sewer maintenance at Oakland, Calif. In order to obtain data upon which to base recommendations, a survey was made of practices in a group of cities within a hundred-mile radius of Oakland, including Modesto, Alameda, Stockton, San Jose, Sacramento, Berkeley, and San Francisco. The information obtained at that time has been brought up to date in so far as possible.

None of these cities has a complete record of its sewer system or a method of record-keeping that will permit the determination of unit maintenance costs. But this situation is probably comparable to that in a great number of American cities. The purpose of this paper is to discuss these conditions and to indicate where modernization of a sewer system may reduce maintenance costs, and what records are necessary to determine the results being obtained. Attention will be called to present construction practices and to improvements made in Oakland since 1932.

INFLUENCE OF LENGTH AND SIZE OF SEWERS

The total length of a city's sewer system is generally obtainable, but the lengths of the different sizes of sewers are not. Table I, giving the total mileage of sewers in eight California cities, shows a tendency for the mileage per 1,000 population to vary inversely with the total population.

The shortest mileage of sewers which will adequately serve an area costs the least for maintenance. The mushroom growth of many California cities has resulted in failure to provide sewers of adequate size for future extensions. This has necessitated the construction of duplicate systems. In some parts of Oakland, for example, there are as many as four operating sewers in one street. With few exceptions, the present practice is to build a sewer of adequate size in place of the existing inadequate sewer or sewers. Where one of a number of duplicate sewers proves troublesome, a good reporting system will detect it. A study may then be made of the combined capacities of the remaining sewers to determine whether the troublesome sewer can be abandoned.

The minimum diameter used for lateral sewers by any of the cities today is 8 in. Nevertheless all the cities have their share of 6-in. and even smaller lines. The city of Oakland has 112.38 miles of 6-in. sewers, of which 2.84 miles have been replaced by 8-in. sewers with WPA assistance at a total cost to the city of $9,037.41. This type of work required hand-labor methods and was therefore costly. While the actual maintenance saving cannot be determined, avoidance of the former inconvenience to residents is adequate justification.

Recently attempts have been made to obtain grades sufficient to produce velocities of from 1.5 to 2 ft per sec, except in limited areas. On combined sewers, silt basins and catch-basins were built to prevent silting, and on sanitary sewers flush tanks were installed to increase velocities. These preventives have been costly to build and maintain and in many cases they are now useless.

San Francisco, on its intercepting sewers on flat grades, constructed large sumps a block long, accessible to the street surface through large trap doors. Difficulty was

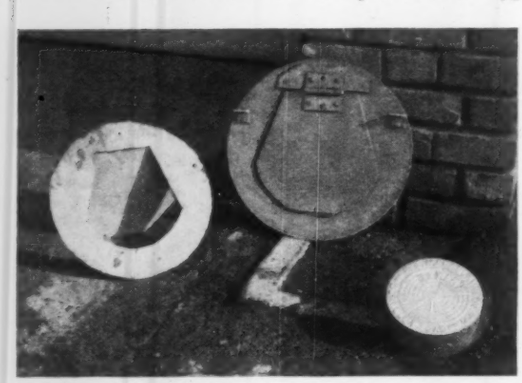
TABLE I. COMPILATION OF DATA ON SEWER SYSTEMS IN EIGHT CALIFORNIA CITIES

City	Population 1930 Census	Miles of Sewers					Manholes	Lamp-holes	Flush Tanks	Catch-Basins	Inlets	Remarks
		Sanitary	Combined	Storm	Total	Per 1,000 Pop.						
Modesto	13,842	46.99	....	5.67	52.66	3.7	394	292	2" tap to manhole	None	Unknown	32.04 miles of 6" or smaller sewers
Alameda	35,033	116.90	....	5.00	121.90	3.5	Unknown	Unknown	All removed	100 ±	Unknown	9.98 miles of 6" or smaller sewers
Stockton	47,963	153.74	....	73.23	226.97	4.7	1,101 Storm 1,574 San.	20	1,052	2,923	See C.B.'s	
San Jose	57,651	....	162	15.00	177.00	3.1	Unknown	Unknown	Unknown being removed	2,000 ±	Unknown	
Berkeley	82,109	289.00	27	9.00	325.00	4.0	2,000 ±	Unknown	.....	1,000 ±	Unknown	27,000 or 75 miles house sewers to property line maintained by city
Sacramento	97,750	....	305	...	305.00	3.2	Unknown	None	Unknown Abandoned	2,000 ±	6,000 ±	
Oakland	284,063	638.88	19.01	50 ±	707.89	2.1	8,428	4,038	12 Abandoned	1,483	2,506	112.86 miles of 6" sanitary. Record not complete on storm.
San Francisco	634,394	6.20	630	...	636.20	1.0	Unknown	Few	None	Unknown	Unknown	8" min. size of lateral sewers

The 1930 census is used because of lack of later estimated populations.
Modesto, Alameda, and Oakland are the only cities having a compiled record of length and size of sewers.

encountered in getting the debris to a continuous bucket elevator from between the doors. These sumps have been practically abandoned and the practice is to wheel muck-filled 5-gal buckets on barrows to manholes, up which they are hoisted to the surface.

Sacramento constructed a saw-toothed bottom in sections of some of the larger sewers to catch debris, only to find later that sufficient velocities were being obtained to keep the sewer reasonably well scoured. Oakland last cleaned its Main Lake sewer, a combined sewer constructed with the flow line completely below high tide, in 1927. Observations taken annually since then show that approximately 18 in. of debris accumulates by the time the rainy season begins. The black color of the discharge from this sewer during storm periods indicates that flushing is taking place.



TWO SIZES OF CATCH-BASIN FLAP GATES USED IN BERKELEY, CALIF., WITH VENT-COVER FOR SIDE SEWERS

These experiences indicate that hand or mechanical cleaning of combined sewers constructed on flat grades is not necessary when seasonal flood flows create velocities in excess of 2 ft per sec. In order to avoid septic action resulting from deposited sewage solids, continuous cleaning would be required. If odor control is necessary, chlorine can be used.

MANHOLE SPACING AN IMPORTANT FACTOR

Location, construction features, and spacing of manholes are the most vital factors affecting sewer maintenance costs. The length of city blocks rather than the convenient distance for rodding sewers has frequently determined the spacing. Fortunately, the 400-ft length of blocks in the valley cities only slightly exceeds the generally recognized maximum distance for rodding. In order to reduce initial expense to a minimum, subdividers have frequently omitted manholes or, at most, installed lampholes.

In order to determine the extent of errors and omissions of sewer structures on Oakland's record maps, the city sponsored an SERA project for a sewer structure survey which was executed under my direction. Many expected discrepancies were found. A wide spacing of manholes, in a number of locations over 750 ft, with an average spacing over 400 ft, was revealed. Many covered manholes were located by means of a sounding bar, and as time permits they are being extended to the surface. The practice of covering manholes with asphalt and gravel when patching streets has been stopped. Additional manholes are being constructed at locations where maintenance requires that access be had to the sewer.

Noisy manhole covers are a constant source of trouble. Asphalt, lead, burlap, and old tire tubes have been tried by various maintenance departments as remedies. The use of asphalt has been the most successful but makes the opening of manholes difficult. Oakland's present specifications require that the cover and cover seat be machined. Noisy covers and frames are being removed and machined, but this practice has not been in effect long enough to determine results. There is still some question as to whether machining of green castings will produce the desired effect, especially when subjected to unequal pressures from street surfacings. Heavier castings, especially covers, and deeper cover seats, with a limited use of asphalt, will be the most effective remedy, in my opinion.

Lampholes have so frequently been misused that the present practice is to avoid them entirely. Berkeley considers them obsolete and is replacing them whenever possible. The other cities make very limited use of them. For use at the ends of lines, Stockton has a commendable design that can be rodded through.

Lampholes may easily be omitted during construction or lost afterward. Over 1,700 lampholes shown on Oakland's record maps could not be located, and 358 were found covered, of which 200 have been raised. Lampholes should not be entirely abandoned, however, as they are economical if installed in accordance with the following rules:

1. A lamphole may be installed on the end of a sewer when it is not more than 200 ft distant from a manhole.
2. A lamphole may be installed between manholes at minor changes in grade or direction when not more than 200 ft distant from either manhole.
3. A lamphole should not be installed at sewer intersections or at drop connections, nor should two or more lampholes be placed between manholes, regardless of the distance between manholes.
4. A lamphole should not be installed on sewers 10 or more feet deep.

Over half the total lampholes on the Oakland system were installed contrary to these rules, making it often necessary to uncover a sewer to relieve a stoppage. In future these lampholes will be replaced with manholes as maintenance requires.

Catch-basins have been built to collect silt and to trap sewer gases. The function of silt collection is no longer necessary because of modern paved streets, except perhaps in places like San Francisco, where streets are cleaned by flushing and outfall sewers are on flat grades and are difficult to enter on account of high water and gas.

San Jose, Sacramento, and Alameda no longer consider catch-basins necessary on combined sewers to trap sewer gases. In Figs. 1(*a*) and 1(*b*)

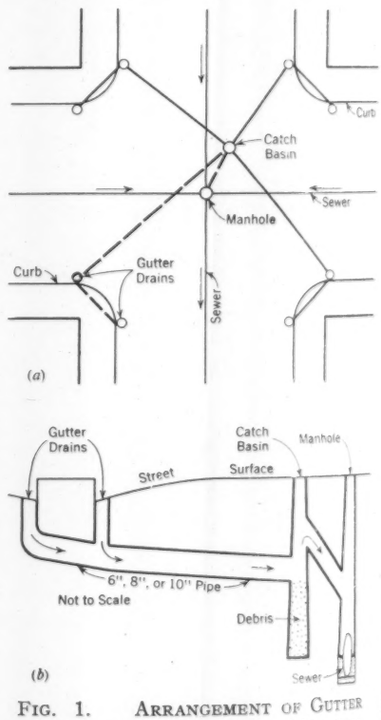


FIG. 1. ARRANGEMENT OF GUTTER DRAINS, CATCH-BASIN, AND MANHOLE, CITY OF SACRAMENTO
(*a*) Plan of Intersection
(*b*) Profile Taken on Heavy Line

is shown an earlier arrangement with catch-basin. Berkeley still considers catch-basins essential, and has provided non-ventilating manhole covers even where sewers are on good grades.

In Oakland, catch-basins have not been built on storm sewers since 1925, although they are still constructed on combined sewers to trap gases at the curb, even though each house is required to have a soil stack, and ventilating manhole-covers are used.

The gooseneck-trap arrangement in some catch-basins, particularly with the larger conduits, seriously interferes with inlet efficiency. Frequently flooding of streets results from the filling of the basin with silt. Berkeley has provided a flap gate to prevent this. It is my observation that the odor of the filth collected in the basin may equal the odor of the sewer gas, that long, dry summers often render the water seal ineffective, and that the stagnant water is a mosquito-breeding nuisance, often causing numerous complaints.

Some further observation and study of the use of catch-basins in San Jose, Sacramento, and Alameda may cause Oakland to follow the example of those cities.

FLUSH TANKS DISCARDED

Flush tanks, installed to increase velocities in sanitary sewers, have now been discarded because of the cost of water, the heavy maintenance cost of metal parts, and the periodic attention required to insure proper functioning. Or the main reason may be that the areas served by the sewers have become populous enough to provide sufficient flow to avoid stranding of solids.

Stockton is the only city attempting to maintain any flush tanks in use. San Jose is removing them as quickly as improvements can be made. Sacramento has abandoned its tanks but has made no attempt to remove them. (A survey might reveal a considerable loss of water through these tanks, as well as a mosquito-breeding nuisance.) Oakland, San Francisco, and Berkeley are fortunate in that very few if any tanks have been installed on their systems.

Flushing of sewers in Modesto is accomplished by running a 2-in. water tap to the upper manhole; in San Jose by a tank carried on a truck; in Oakland and San Francisco by eductors. A hose run to a fire hydrant is used where possible.

PROBLEMS OF SEWER JOINTS AND HOUSE CONNECTIONS

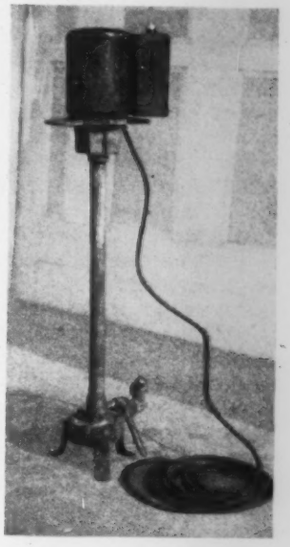
Poor sewer joints have without doubt given the most maintenance trouble, permitting the entrance of sand, tree roots, and in the rainy season, excess ground-water infiltration, causing spouting of manholes. Cement is the jointing material most used, although San Jose and Bakersfield use asphalt under certain conditions. Neither of these materials has produced good results in Oakland, particularly on private contract work.

In 1933, after a year of experimentation, Oakland adopted as standard a sulfur-silica jointing material. During the past year, using this jointing material, 18,826 lin ft of 8-in. lateral sewers have been reconstructed with the aid of WPA funds in one of the most troublesome areas. The results obtained in excluding ground water and roots are being observed with interest.

In my opinion, the character of the jointing material is secondary to the workmanship, and in order to ensure good workmanship a hydrostatic test and more rigid inspection will be necessary. The flash test of sewers, now employed during flooding of trenches, is inadequate.

House sewers are reported to give the most trouble from stoppages, largely because of their shallowness, accessibility to roots, and poor jointing. Except in Oakland and Modesto all these cities construct house sewers to the curb line or make the main or lateral sewer tap. Considerable damage has been done in Oakland to main sewers by lax inspection of house-sewer construction. More stringent inspection will have to be adopted, or perhaps the practice of other cities followed. In Oakland a city inspector is employed on all public-utility construction work to prevent damage to house and lateral sewers. It is good practice to provide Y-sections for house-sewer connections at the time the lateral sewer is constructed. San Francisco constructs the house sewer to the curb, marking its location with a redwood stake or an "S" in the concrete curb. Berkeley constructs 4-in. vents, with cast-iron caps, plainly labeled "sewer," just behind the curb.

Sewer systems are frequently misused. Roof leaders are often connected to sanitary sewers, and leaves and garden trimmings are often deposited in catch-basins or inlets. These practices result in many maintenance calls on account of flooded basements, lifted manhole covers, and stopped storm-water inlets.



ONE-INCH PORTABLE ELECTRIC PUMPS ARE USED TO PUMP WATER FROM BERKELEY BASEMENTS WHEN SEWERS ARE OUT OF ORDER

No method has yet been devised to determine when a sewer has served its useful life and how reconstruction is to be financed. During the period November 1931–1933, Oakland replaced (enlarging where necessary) 7.23 miles of old concrete combined sewers that had served approximately fifty years, and also constructed 4.72 miles of new sewers, at a total cost of $291,901. The old concrete sewers, which were all in the relatively flat, sandy section of the city, had required constant flushing. Records show a decrease of $1,095 in cost of water between 1931–1932 and 1935–1936, much of this saving being due undoubtedly to the replacement of these sewers.

Practice indicates that sewer maintenance crews of three men function most efficiently. Such crews consist of a truck-driving foreman and two laborers, reporting to the city engineer in the smaller cities and to the superintendent of sewers or sewer foreman in the larger cities.

On a population basis, the Oakland organization is large compared with the other cities, but it is more self-contained and assists other departments. Four crews have been busy on Oakland emergency relief, SERA, or WPA work, a practice that is insuring good work.

Sewer labor requires a certain amount of specialized training, which makes it difficult to draw men as needed from the unskilled labor roll. The work is more or less hazardous as well as disagreeable, which circumstance should be reflected in wage scales. This is done by classifying labor on sewer work as sewermen, skilled sewer laborers, or skilled or semi-skilled labor.

The equipment in use by the eight cities is fairly comparable. Small tools are generously supplied. Some benefits would result from standardization—for instance, some four types of sewer rods are being used, with few if any rods of one make in reserve for an emergency.

Equipment carried on the maintenance trucks of the

various cities is nearly identical. In the case of Oakland, three sewer maintenance trucks are provided with pumps, while five are not. Each truck carries the following equipment: 40 sewer rods, 1 set sewer rod tools (comprising 4 and 6-in. root cutters, spear and spiral), 1 set of steel sewer rods and tools (2 sets only in use), 1 straight nozzle for flushing, 1 hydrant spanner, 1 hydrant gate valve, 300 lin ft $2^1/_2$-in. fire hose, 3 shovels, 6 picks and 3 handles, 1 earth tamper, 1 sledge-hammer, 1 cement trowel, 1 bucket, 2 pairs rubber boots, and lanterns.

Sewer machines are of some value in freeing badly stopped sewers until other measures can be taken, but a sewer which has been stopped so as to require the use of a sewer machine will have to be dragged with increasing frequency, and is generally so damaged that it needs reconstruction.

DUMP TRUCK FOR SEWER MAINTENANCE, CITY OF OAKLAND

3-In. Pump in Front. Tools Are Carried on Running Board and in Bed of Truck

Maintenance departments often develop useful gadgets to assist them in their most difficult problems. Sacramento, by spreading the strands at the end of a cable, forms a burr to cut and dislodge roots. San Jose winds barbed wire back and forth between two 3-in. diameter steel rings 3 ft apart. A piece of chain expands the barbed wire into a burr. This device, when pulled through the sewer by a cable attached to a truck, is said to produce good results. Berkeley has developed 1-in. portable electric pumps for connection to house circuits in pumping of flooded basements until the sewer trouble can be determined and repaired.

In each of the cities there is a marked absence of the safety equipment necessary for the hazardous job of cleaning large outfalls where there are accumulations of gas. Public service companies always check a manhole for gas with a safety lamp or gas detector before it is entered. San Francisco has provided electric lanterns. Oakland has recently purchased gas masks capable of protecting life for two hours, providing oxygen is present, and a safety lamp. In general sewermen are continuing to substitute for canaries, entering manholes slowly with ropes tied to them, trusting that they will be pulled out and revived if overcome.

Safety lamps and gas detectors should be the first items on the equipment list of a sewer maintenance crew, and portable air blowers should be provided to ventilate sewers or manholes where gas is detected.

RECORDS ASSIST IN KEEPING DOWN COSTS

The costs of sewer maintenance given in Table II are budget appropriations, except for Oakland, but are said to be close to actual costs. From the table it can be seen that the cost per mile of sewer for maintenance increases directly with the population, which can be accounted for by the costliness of cleaning large outfall sewers, and by the increased cost of maintenance of sewers long in service. It also shows that the per capita maintenance cost varies inversely with population.

Only by keeping adequate records can the efficiency of a department or its divisions be determined. Each of the northern California cities has certain records of merit, but none are entirely complete.

Records may be divided into three groups—operative records, supporting records, and route or maintenance progress records. Operative records should include a complaint sheet, work order, daily report, equipment operator's report, unit cost record, monthly report, and an annual report. Records should require a minimum amount of writing because maintenance men frequently lack descriptive ability and write illegibly.

The complaint sheet used by the city of Berkeley is well adapted to the purpose, as it requires little writing and the nature of the complaint is easily determined. Berkeley files complaints for a period of one year—a good practice which facilitates the compilation of monthly and annual reports, and the checking of recurrence of complaints.

The daily report and the equipment operator's report should provide space for units of work performed, such as number of catch-basins cleaned, length of sewer flushed or relaid, and structures built, rebuilt, or repaired. Monthly report sheets with proper headings will ensure more uniformity and permanence of records for long-time comparison. The unit cost record may be consolidated with the monthly report. Variations in unit costs indicate relative efficiencies of methods, equipment, and employees.

The second group of records, termed supporting records, is kept by the engineering department to assist those in charge of sewer maintenance. These should include record maps, indicating locations, lengths, size, depth, age, material, and elevations of sewers; and a Y-branch or side-sewer record.

The third group of records, route or maintenance progress records, are not used except by Berkeley, which has established regular sewer patrols on a weekly or monthly basis. These have resulted in a reduced number of complaints and better service. The following description of these records indicates their purposes:

1. Map showing catch-basin locations, and route to be followed in cleaning, on which progress may be marked with pins.
2. Map showing manholes and sewers requiring periodic flushing, and routes to follow, on which progress may be marked with pins.
3. Map showing wet-weather patrol areas or routes, and indicating intersections, school areas, main arteries, and commercial areas where flooding is likely to occur.

TABLE II. RECORD OF SEWER MAINTENANCE COSTS FOR EIGHT CALIFORNIA CITIES

City	1930 Census	Maintenance Appropriation	Annual Cost		Remarks
			Per Capita	Per Mile	
Modesto	13,842	2,300.00	$0.166	44	Note 2
Alameda	35,033	2,869.97	0.082	24	
Stockton	47,963	12,348.00	0.257	56	Note 5
San Jose	57,651	9,020.00	0.157	52	Note 1
Berkeley	82,109	5,317.50	0.065	17	
Sacramento	93,750	25,100.00	0.268	84	Note 5
Oakland	284,063	44,126.12	0.155	62	Notes 4 & 5
		38,508.92	0.136	54	
San Francisco	634,394	62,900.00	0.099	98	Note 3

1. San Jose carries side-sewer construction as a separate account; materials $500, labor $2,058, total $2,558, and revenue $3,977.44.
2. Modesto expends $3,475 per year on sewage treatment in addition to amounts here tabulated. No charge is made for water as system is municipally owned.
3. The City of San Francisco by budget appropriation also allows $157,356 for contractual service in constructing sewers and extensions. The large expenditure for replacements and equipment is due to the fact that the city rents all its trucks and wagons with drivers.
4. Actual expenditures for fiscal year 1931–1932. Underlined expenditures are for fiscal year 1935–1936. No definite amount is appropriated for sewer maintenance. The allowance for such maintenance is a part of the budget allowance to the street department.
5. If water is neglected, the annual cost figures for Stockton are $0.182 per capita and $40 per mile; for Sacramento, $0.233 per capita and $72 per mile; and for Oakland, $0.149 per capita and $60 per mile.

The Influence of Major Highway Improvements on Traffic Accidents

IT IS REASONABLE to expect that the large sums being expended today to effect certain major improvements on through highways should result in material benefit as shown by the accident records on these highways. In large part this is the purpose in view. In New Jersey this has been found to be actually the outcome, as demonstrated by Arnold H. Vey, State Traffic Engineer, in his address before the Highway Division on January 21, 1937. His references to various state records, indicating the effect of the improvements on traffic accidents, both qualitatively and quantitatively, will be briefly summarized.

Most if not all highway accidents are attributable to shortcomings in the automobile, the highway, or the highway user. Of these the greatest responsibility rests on the user, either driver or pedestrian, regardless of whether his action was wilful, negligent, or due to ignorance. To cure this situation, education is helpful, but basically the roadway facilities themselves must be made inherently safe in order to render the failings of human beings of less or of little importance.

A measure of the problem is indicated by the accident records of the State of New Jersey for 1934, comprising 25,000 miles of road, 1,500 miles of this being state highways. In a total of over 33,000 accidents 3.5 per cent involved fatalities, 55.9 per cent involved personal injury, and the remaining 40.6 per cent concerned property damage only. The 6 per cent of state highways were the scene of 21 per cent of the accidents. Unfortunately the corresponding vehicle miles are not available for comparison. In terms of the proportion of fatal accidents, the state highways were almost twice as dangerous as the others, presumably because of their higher average speeds.

Still other comparisons are of interest. About 40 per cent of all accidents occurred at street intersections, while 60 per cent were between intersections. Parts of the state highway with little or no cross movements were therefore the more hazardous. Although only one-fifth of the 24-hour traffic was at night, 46.3 per cent of the accidents occurred during hours of darkness.

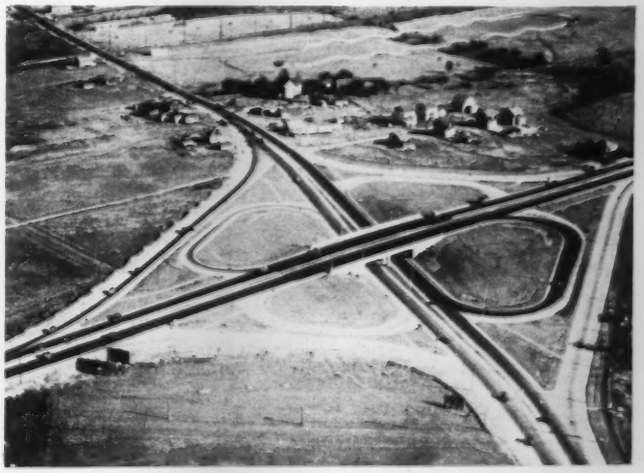
Comparisons of records covering roads of differing widths gave rather surprising results, in terms of accidents per million vehicle-miles. The figures are: for two-lane roads, 2.75; for three-lane, 3.50; and for four-lane, 3.61. Apparently, and contrary to common belief, the wider the road the more hazardous it is. This is particularly surprising as related to the three- and four-lane comparison. One explanation may be in the fact that the wider the road, the more flexible the movement from one side to the other.

These basic relations are further borne out by the comparisons in terms of severity. The order of sequence remains. The percentage of fatal accidents was found to be, for two-lane roads, 5.05 per cent; for three-lane, 6.24 per cent; and for four-lane, 6.27 per cent. Despite the increase for wider highways certain types of accidents decreased, notably right-angle collisions.

Compilation of many records indicated a relation between total traffic and accident rates, as given in Fig. 1. Segregating the accidents by type it was found that 14 per cent of the total occurred at intersections, owing to right-angle collision, and 10 per cent from vehicles going in the same direction (rear-end, side-swipe, and cutting-in collisions), while 20 per cent of the total occurred between intersections from cars moving in the same direction, and 18 per cent from head-on collisions. By applying known highway improvements, such as controlled rights of way, physical separation or segregation of conflicting flows of traffic, adequate shoulders for stopping, pedestrian pathways, and modern highway lighting, Mr. Vey concludes it would be possible to reduce accidents by 75 per cent.

A number of "before" and "after" records of accidents in New Jersey indicate a definite reduction by virtue of major highway improvements. Such changes make it less possible for highway users to perform improper practices causing accidents. Even these improvements, however, are not cure-alls and in view of the impossibility of immediate reconstruction, it remains necessary, through educational endeavors and enforcement activities, to cause drivers and pedestrians alike to acquire safe highway habits.

SEPARATED ROADWAYS DECREASE ACCIDENT HAZARD
On New Jersey Highway System, near New Brunswick



ELIMINATING DANGERS AT INTERSECTION OF MAIN HIGHWAYS
Woodbridge Clover Leaf, Routes 4 and 25, New Jersey

The Rezoning of Urban Areas

Explaining the Use of Revised Land-Use Factors, with Methods of Application

ALTHOUGH great progress in the arts and sciences has been achieved in the past few years, nevertheless congested areas, blighted districts, and slums are still with us, said Hugh E. Young, M. Am. Soc. C.E. chief engineer of the Chicago Plan Commission in his address before the City Planning Division on January 21, 1937, at the Society's Annual Meeting. But it must be remembered that only 20 years have elapsed since American city planners began pioneering in the field of zoning, and considering the magnitude of the task, the zoning done to date has been truly creditable. Since 1916, when the first zoning ordinance in the United States was adopted in New York City, some twelve hundred American cities have zoned their areas for use and volume. Today perhaps 75 per cent of the nation's entire urban population lives in zoned cities.

A Typical Scene in Chicago's Blighted District

As a result of the experience thus developed, zoning is now producing a technique of its own. Definite standards are being established with which it will be possible to determine how closely any given zoning ordinance conforms to accepted norms. Anticipated trends of 15 or 20 years ago can be compared with actual conditions, giving a dependable measure of future use and volume requirements. Facts have been discovered relative to the proper proportioning of urban area for residential, commercial, and manufacturing use in accordance with population requirements. Experience has shown that there is need of tapering off or shading of one use into another, instead of drawing an arbitrary line. Thus it is that a majority of American cities, both small and large, feel that rezoning is now necessary.

In studying the need for rezoning it is clear that the most important factor is the item of present land use. Researches must be carried out in the larger cities as well as in the small ones, since use factors which obtain in a city of less than a quarter million people cannot be taken as applicable to cities of two or three million or more. For example, although the proportion allocated to total dwelling area in Chicago is about the same as that used in several groups of smaller cities, in each instance the ratio of single-family dwellings to apartments is much greater in the smaller communities. Also, a much larger proportion of the city area must be devoted to commercial and manufacturing uses in large cities than in small ones.

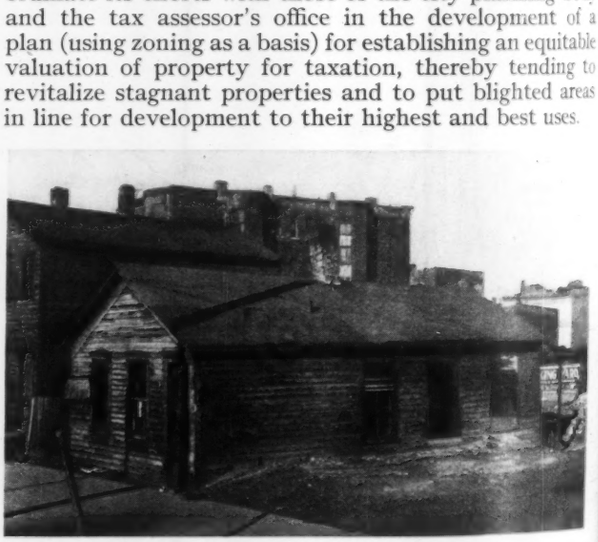
Lack of knowledge about present use factors has resulted in the zoning of miles upon miles of spurious commercial frontages, in the illogical placement of manufacturing areas, and in the allocation of dwelling areas out of line with natural development. This kind of zoning prevents proper tax valuations and results in much tax delinquency. It also causes the city to lose the revenues that would have been obtained from such areas if they had been developed to their highest and best use. Recent surveys indicate that the resulting deficit is usually borne by about 10 per cent of the more highly developed property of the city.

Having thus established the need for rezoning, particularly in the larger cities of the country, the question arises, "What is a practical method of rezoning?" The first requisite is a comprehensive land-use survey. If this cannot be had, then insurance plats, census data, assessor's cards, and other sources should be studied.

The second step is the preparation of an official rezoning plan, based on present use factors which have been carefully compared with the average use factors of other cities in the same population group to determine the correct ratios of various uses per 100 population. Applying these factors to a close estimate of future population, the proportional area to be allocated to each of the various uses can be fixed, and additional area annexed if the existing vacant area is insufficient.

After the rezoning plan is complete, the next step is to secure public approval of it. One method of obtaining this approval is by educating the people as to the economic benefits to come from the proposed rezoning. Other methods stress the rehabilitation of blighted areas as the vital problem necessitating rezoning, with low-cost modern housing to be provided (1) by a local housing authority through a loan and grant by the federal government, or (2) by a funded housing trust, also financed by the federal government, or possibly (3) by the utilization of both methods of financing rehabilitation—one a purely government-controlled project and the other a means for putting the property owner in the picture under a trustee-ownership plan.

Formation of a strong, non-political citizens' committee is advocated by Mr. Young as an aid in popularizing the rezoning plan and in preserving its integrity thereafter by backing up the zoning board of appeals in refusing to grant improper variations. He further advocates the idea of having this citizens' committee coordinate its efforts with those of the city-planning body and the tax assessor's office in the development of a plan (using zoning as a basis) for establishing an equitable valuation of property for taxation, thereby tending to revitalize stagnant properties and to put blighted areas in line for development to their highest and best uses.



Rezoning Is Essential in the Larger Cities Before Blighted Areas Can Be Rehabilitated

One-Fourth of Chicago's Area Has Two-Fifths of Its Population

Past and Future of Power Division

Abstracts of Addresses Delivered at the Society's Annual Meeting on January 21, 1937

Survey of the Power Division

By LYNNE J. BEVAN

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, NEW YORK, N.Y.

THIS survey of past activities of the Power Division is made as a background for the development of its future activities. At the same time, such a review affords considerable satisfaction to a large number of our members who have participated in the formation of the Division and in the many exceedingly useful discussions of practice and problems in our special field.

While it is only some 14 years ago that the first of the Divisions actually came into existence, it was in 1882 that a proposal was made to amend the Constitution of the Society to authorize what were called "Sections," each "for the advancement of a special branch of engineering." This amendment failed of passage in 1883. While it was being discussed, the formation of such "Sections" was severely criticized by members who thought that the Society would be weakened by holding separate technical meetings at the same time as the Annual Meeting or Convention. Out of this criticism, however, there grew the constructive suggestion that members residing too far from New York to attend many meetings would profit by the establishment of Sections. However, for nearly forty years nothing was done about it.

Under date of February 8, 1922, John P. Hogan, then a Director, endorsed and forwarded to President John R. Freeman, a letter from Irving Weed, a member, asking for a Power Section. Evidently the suggestion was referred to the Committee on Technical Activities and Publications, as that committee appointed a subcommittee on power and recommended to the April 1922 meeting of the Board of Direction that a by-law be prepared to make provision for the orderly formation of professional divisions within the Society. At the June 1922 meeting of the Board, a Technical Division on Power was authorized, and on October 2, 1922, the by-law, Article VIII, was formally adopted, providing for uniformity to a reasonable extent in the organization of the various Technical Divisions. The Power Division was thus in the first group authorized, the other Divisions authorized in June 1922 being the Highway Division, the Irrigation Division, and the Sanitary Engineering Division. City Planning was authorized in July 1923; Structural in April 1924; Waterways in June 1924; Construction in October 1925; Surveying and Mapping in January 1926; Engineering-Economics and Finance in January 1931; and Soil Mechanics and Foundations in July 1936.

The actual organization of the Power Division occurred on January 19, 1923. Its first executive committee was composed of the following notables in the power field: George A. Orrok, chairman; Francis Blossom, managing engineer, Sanderson and Porter; Frederick W. Scheidenhelm, consulting engineer; Edward Hutchins, engineer with the International Paper Company; and Nathan C. Grover, chief hydraulic engineer, U. S. Geological Survey.

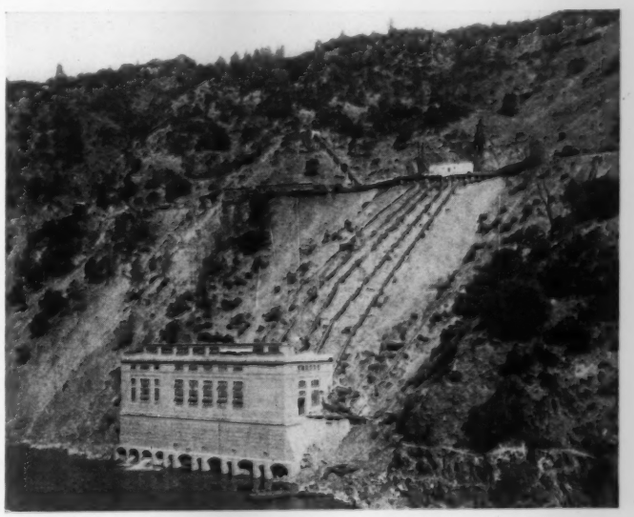
This committee promulgated an "enrollment circular" which invited membership in the Division (dues $1.00 per year) and set forth the "purpose and aims" of the Division as follows: "The Power Division will not be a new or separate organization, but merely a gathering together within the American Society of Civil Engineers of those interested in power. Its activities are expected through discussion, papers, studies, and research to assist the designer, constructor, and operator of power plants in the solution of their problems. The functions of the Division will be more definitely determined by the executive committee, and a program will be laid out, by that committee, designed to produce the greatest results with the least possible duplication of the work now being carried on by other bodies."

PURPOSES AND AIMS OF POWER DIVISION

This enrollment circular resulted in the registration of 240 members in the Power Division. The purposes and aims, thus formally set forth, have been supplemented by the first chairman of the Division as including:

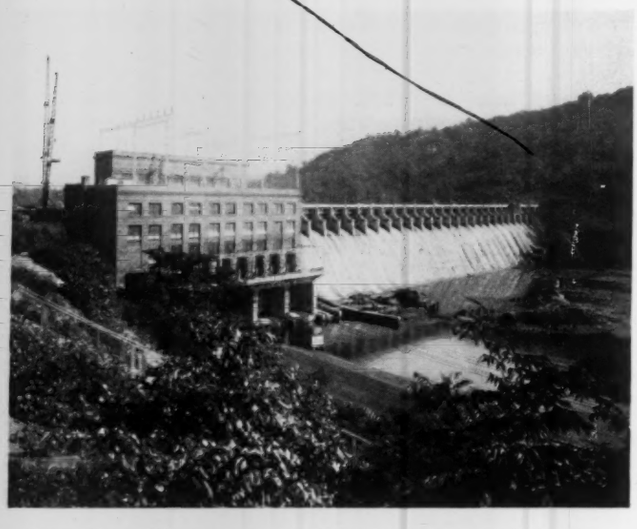
1. Emphasis upon the importance of civil engineers in connection with hydroelectric development. Emphasis upon the fact that the water supply and regulation, the dam, the water conduits, the hydraulic controls, and the design of scroll case, draft tube, and tailrace are fundamentally civil and hydraulic engineering problems.
2. Education of civil engineers in the problems and opportunities in the power field, especially in hydroelectric work.
3. Education of civil engineers in the interconnection of hydro and steam-power sources in various markets.
4. The development of uniform practice in hydraulics and power.
5. The encouragement of research and study to improve efficiences in waterways and water wheels, and in the measurement of flow.

With these objectives before it, the executive committee promptly set up a program of Division sessions



POWER PLANT AND PENSTOCKS, BIG BEND PLANT, FEATHER RIVER, CALIFORNIA
A Unit of the Pacific Gas and Electric Company

to realize them. In the period from July 11, 1923, when first Power Division session was held, up to and including its latest session on January 21, 1937, a total of 82 papers were delivered (listed in detail in the original paper). Of these a majority were intended to assist the



LAKE LYNN HYDROELECTRIC PLANT NEAR LAKE LYNN, PA.
Built by West Pennsylvania Power System on Cheat River

designer, constructor, and operator. Breaking down the total papers among the various specific objectives of the Division, the following analysis is obtained:

1. To assist the designer, constructor, and operator, 20 papers.
2. To emphasize the importance of the civil engineer, 5 papers.
3. Education of civil engineers in the power field, 30 papers.
4. Education of civil engineers in the matter of interconnection, 4 papers.
5. Development of uniform practice, 4 papers.
6. Encouragement of research toward efficiency, 14 papers.
7. Government as it touches power development, 4 papers.
8. Education of the public with respect to power projects, 1 paper.

In the early years of the Power Division three new members were elected to the executive committee each year. Lack of continuity of personnel and point of view was a serious handicap, and in 1928 the system of elections was modified so that only one member would be replaced each year. This man is selected by a nominating committee appointed by the executive committee, and is actually appointed by the Board of Direction of the Society. The committees of the Power Division have been far less indicative of its purposes than the papers presented at meetings. Only three formal committees have served the Division.

The Committee on Ice as Affecting Power Plants was formed immediately after the presentation on July 11, 1923, of the paper by W. T. Walker, Construction Superintendent of the Northern States Power Company of Minneapolis, and had for its objective the study of the ice problems outlined in that paper. F. C. Shenehon, consulting engineer of Minneapolis, was chairman, and the other members were John R. Freeman, Daniel W. Mead, John L. Harper, L. C. Sabin, and W. T. Walker. By March 1925, it was noted in PROCEEDINGS that "the Committee on Ice Problems had been organized and is now attempting to lay out a program that will enable it to cooperate with various other agencies working to the same end." In June 1926, the Division directed the secretary to inform the chairman of the Ice Committee that a report should be submitted within four months showing actual progress or the committee would be discontinued. Eventually, however, at the January 1929 meeting of the Power Division, the committee presented a creditable report and a complete bibliography—all as published in Vol. 95 of TRANSACTIONS (1931).

The Committee on Silting was constituted in March 1924 in response to a request by the Hydro-Technical Society of France for data relative to silting of canals and reservoirs in the United States. Under Thorndike Saville as the original chairman, the committee compiled a mass of data through questionnaires to power companies and engineers. Mr. Saville resigned the chairmanship in 1926 "on account of temporarily leaving the United States." He was succeeded by Andrew Weiss, of the J. G. White Engineering Corporation, who added additional data and then was transferred to Mexico. He was followed by Gen. G. W. Kutz, who prevailed upon J. E. S. Thorpe of the committee to start the work of analysis and editing of the large amount of data in the committee's hands. In the summer of 1931, John C. Stevens, then a member of the Power Division's executive committee, at the urgent request of the Irrigation Division and the Society's Committee on Irrigation Hydraulics, undertook the compilation of the report. In October 1933, the comprehensive report was submitted. It was published in Vol. 101 (1936) of TRANSACTIONS.

The Division's Committee on Legislation with Respect to the Safety of Dams was appointed in January 1930, immediately following the excellent paper, "State Supervision of the Design and Construction of Dams," by Arthur H. Markwart, M. Am. Soc. C.E., vice-president of the Pacific Gas and Electric Company. L. F. Harza was chairman, and Robert A. Monroe, subchairman. The report of the committee was presented at the June 1933 meeting of the Division and included a carefully prepared model law to serve as a guide to those drafting such a law in any state.

Inasmuch as a question of policy of the Division was involved in the work of this committee, certain quotations from CIVIL ENGINEERING of August 1933, with respect to the report of this committee may be given: "At the time the committee was formed it was expected that numerous states would be enacting legislation which might be so restrictive as to prohibit development in the design of dams. It was hoped that the committee would be an influence in directing such legislation along sound lines. Although the committee favors regulatory legislation in the interest of public safety in states where the failure of dams would cause damage to property and loss of life, it does not advocate the general promotion of such legislation by the Society. Rather, members of the Society should support or oppose such legislation in their own states as local circumstances indicate." The model law submitted by the Committee on Legislation with Respect to Safety of Dams is in the Society files and is commended to any of our members who may be thinking along this line.

SUPPLEMENTARY OBJECTIVES

This survey would be incomplete without a few words with respect to the supplementary objectives which from time to time have appeared in the minutes of the Division's executive committee and elsewhere. In January 1926, three years after the formation of the Power

Division, the Board of Direction of the Society set up the Committee on Technical Procedure, composed of two Directors and the chairmen of the Research Committee, the Technical Activities and Publications Committee, and the several Division executive committees. The Committee on Technical Procedure was intended to be a coordinating and stimulating agency for all committees of the Society. At the same time the Board asked the various Divisions to amend their constitutions to give greater continuity to the membership of the executive committees (which was duly done by the Power Division), and the Board "placed responsibility on the Technical Divisions:

"(*a*) for suggesting lines of study and research in their respective fields; and

"(*b*) for stimulating and guiding the technical activities of the Society, as a whole, in so far as the several divisional specialities are concerned;

"(*c*) for appointing a Committee on Papers and Specifications for the purpose of outlining subjects, and suggesting names of members qualified to follow particular lines of work or investigation."

The Board, however, left to each executive committee the determination of how it might best function, requiring only that each executive committee should submit an annual report of work done and of proposed future activities. Thus the Board would restrict the Power Division to the technical phases of engineering, presumably from a fear that the Society might be discredited if a member should express views at Society meetings which might be construed as political in nature.

However, the Division's executive committees have recognized that rarely are projects technically good if they are economically unsound. Beginning about 1930, the executive committees have therefore endeavored to develop papers on the enconomics of power, as for instance the 1930 "Report on the Status and Progress in the Art of Power Engineering," by George A. Orrok, M. Am. Soc. C.E.; the paper by George I. Rhodes, in 1931, on "Natural Gas for Steam Power"; and, in 1933, Daniel W. Mead's "Analyses of the Proposed Official Plans for Water Power Development on the International Section of the St. Lawrence River." Among the topics under consideration by the executive committee in 1932 was "Public Ownership of Utilities in Its Economic and Political Philosophies from a Fundamental Standpoint." While the Division did not succeed in getting this paper presented, the Engineering-Economics and Finance Division did hold a symposium in January 1934, on "The Equitable Theory of Government Ownership and Operation."

In conclusion, this survey finds that the 15 years of the Power Division have produced remarkable technical improvement in the generation, transmission, and distribution of both steam and water power, and that the Division has substantially increased the usefulness of the Society to its members by promoting papers and discussions that have broad technical and economic value.

A foundation has been laid, upon which activities of less restricted scope may be developed. Earlier Boards of Direction of the Society have been inclined to limit the Power and other Divisions rather closely to technical discussions. However, many factors, perhaps the depression period principally, have brought the Board and the members of this Division to a realization of the fact that those who have spent years of specialization in power (or any other branch of engineering), have a social responsibility to present to the nation economic conclusions in the power field.

Future Course of the Power Division

By FORD KURTZ

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
HYDRAULIC ENGINEER, THE J. G. WHITE ENGINEERING CORPORATION, NEW YORK, N.Y.

ONE of the original four Technical Divisions, the Power Division is in its fifteenth year of existence. The date of its authorization by the Board of Direction, June 20, 1922, might be said to coincide with the beginning of that great post-war expansion of the power industry which so completely engaged the services and challenged the engineering and construction abilities of the host of engineers who have devoted their professional careers to the creation of facilities for the production of industrial power. The fifteen years that have since elapsed have seen the rise—and in some cases also the fall—of great physical and financial consolidations of power facilities. These consolidations inevitably led to the creation of larger individual power units and power plants. When, seven years ago, there fell upon all industry the withering blight of which we still feel the dire effects, this tendency was not halted, for the Boulder project of stupendous size was already under way, soon to be followed by the huge publicly financed projects on the Tennessee, the Columbia, and the Missouri, as well as many similar undertakings of lesser but still notable magnitude.

When I received my appointment to the office of secretary of the Division's executive committee on May 15, 1934, private power development was at a very low ebb. The question which presented itself most insistently to the executive committee in the then existing state of affairs was, "What manner of technical activities can the Power Division undertake to serve best the interests of its members?" There were in existence but two Division committees—one on silting, the work of which was far advanced and nearing completion, the other on water hammer. The former was cooperating with the Irrigation Division and the Hydro-Technical Society of France; the latter was a joint committee with the Hydraulic Division of the American Society of Mechanical Engineers. The Power Division's chief medium of activity was therefore the presentation of papers at meetings of the Society. Including joint sessions with other Divisions and with the Hydraulic Division of the A.S.M.E., not more than two Division meetings during the year were considered desirable. As it developed, only one meeting was actually held in 1934, but two were arranged for 1935 and for 1936.

During the past year the executive committee has adopted a new policy relative to the selection of its members. It had been felt that a geographical distribution of the members would facilitate greatly the successful planning and carrying out of the sessions of the Division held in various parts of the country. A study of membership distribution was made and a plan adopted to apportion the five members of the executive committee to five geographical divisions, two of which correspond with the southern and western sections used by the Society in the selection of sites for the Spring Meetings and Summer Conventions, respectively, the remaining three comprising the northern section, in which the Fall Meeting of the Society is held. Of these latter three divisions, one is made up of the Metropolitan District, one comprises the Middle Western District, and the other includes New England, New York, New Jersey, and Pennsylvania, exclusive of the Metropolitan District. After January

1938, there will be at all times one member of the executive committee from each of these five geographical divisions. Furthermore, in the selection of nominating committees, the majority of the members will be chosen each year from the district from which a new member for the executive committee is to be appointed. We hope that this policy will result in even more widespread and active interest of the membership in Division affairs than ever before.

Unlike the others, the Power Division's field lies to a major degree within the sphere of influence of three of the Founder Societies—Civil, Mechanical, and Electrical. Is

REUSENS HYDROELECTRIC PLANT ON THE JAMES RIVER, IN VIRGINIA
Part of the Appalachian Electric Power Company

it desirable to attempt to define and then limit our Division activities to that part of the field which decidedly lies within the province of civil engineering, namely, hydroelectric power minus its technical electrical features? If not, how far should the Division interest itself in those sections whose details admittedly pertain to mechanical or to electrical engineering? Our executive committee has pondered over these questions but without answering them.

And now the executive committee feels that the time has again come to repeat the question of 1934: "How can we as a Division best serve the interests of the membership?" The committee wishes to obtain from the membership of the Division the widest possible expression of opinion before adopting a policy for the future. The committee places before the membership no formal proposal, but it is at the request of its chairman that I present briefly my ideas on the subject.

First, as to the holding of sessions of the Division, I recommend that at least two, but not more, be held each year—at the time of the Annual Convention and at the time of the Annual Meeting. If either or both of these are joint sessions with another Technical Division of our Society, I think it would be entirely proper to hold a third session, either jointly or alone, at the time of either the Spring or Fall Meeting of the Society.

Second, as to the subject matter of papers, I feel every effort should be made to secure, first of all, papers on smaller and moderate-sized hydroelectric plants, which are now again coming into design and construction stages under the auspices of private capital. It is with such plants that many of our membership hope to become connected in one capacity or another, and I believe they would like to have presented papers relating to all the latest developments in this class of plants. In second place I would put papers on the moderate sized hydroelectric plants now under construction or nearing completion with funds provided by RFC loans or PWA loans and grants. I would place third any further papers on those large federal power projects to which we have devoted a great deal of attention as a Division during the past 2½ years. I feel that the technical record of such plants is already voluminous and will continue to grow without the aid of the Power Division.

The third subject is the matter of papers resulting from special committee studies and reports. It is one on which we now start with a blank page. Let us look at the activities of the other Divisions in special committee work as shown by the 1936 Year Book of the Society. When a committee is a joint one, I have called it a half committee for each Division cooperating. On this basis the City Planning Division now has 5 special committees; Construction, 1½; Engineering-Economics and Finance, 3; Highway, none; Irrigation, 5½; Sanitary, 10½; Structural, 8; Surveying and Mapping, 11; Waterways, 2½.

It is evident that we are lagging in this matter and I feel the Division should at once adopt a policy of resuming and building up its special committee work—not too rapidly, but modestly and well, starting with only a few that fill real and pressing needs of the membership. As to these needs, only the Power Division membership can give the answer.

The first subject of study I wish to suggest is that of power cost. I envisage a committee functioning for a number of years, first accumulating data on standard account classifications for cost of power both hydraulic- and fuel-generated; second, setting up its own recommended system of accounts for analysis of all the elements of power cost; and third, collecting and tabulating in accordance with that system accurate and reliable data on the cost of power. Today one cannot accept any of the numerous generalized statements on cost of power because they are apt to be influenced by the glossing over of one or more elements of true cost. Here, in my opinion, is a much-needed subject of investigation, one on which an annual report would be of inestimable value.

The second subject is in a way an item of the greater subject just discussed. This is "Power Plant Depreciation and Obsolescence," particularly in respect to the observed life of power-plant equipment. It is an important element in power cost and one on which there is the widest variety of practice and opinion.

The third subject is one suitable for a standing committee making annual reports to the Division, namely, "Progress in Power Plant Design." This committee should take up the design of hydroelectric power plants in considerable detail, and fuel plants in a general way and to the extent that civil engineers should keep informed on them.

The fourth subject is an item of the third, which I would deem worthy of a separate committee, acting in general along the same lines as the third, namely "Progress in Prime-Mover Design and Efficiency." This committee likewise would make an annual report.

The fifth subject is valuation of power plants. My idea on this would be to discuss with the Engineering-Economics and Finance Division the advisability of including, in the membership of its valuation committee, a member from each of such Technical Divisions as would care to cooperate with it on the subject of valuation standards.

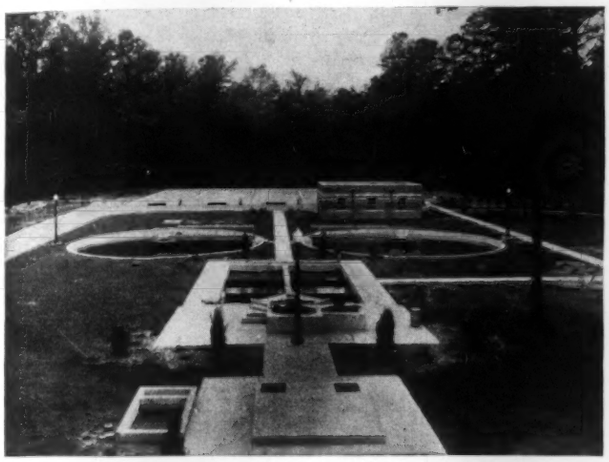
The sixth possibility would be a special committee to collect and publish data on the various forms of public authorities or corporations handling power plants, with such recommendations as it saw fit to make. This committee might include a study of the proper allocation of costs in projects where development of power is only one of several purposes, with pertinent recommendations. Perhaps it is a little late to undertake this latter subject as all the major decisions on large projects might be made before this committee could carry out its work.

Reports of Sanitary Engineering Committees

As Prepared for the Division's Annual Meeting in New York on January 21, 1937

Committee on Chemical Treatment of Sewage Makes Progress Report

IN A PRELIMINARY statement submitted a year ago, in January 1936, the Committee on Chemical Treatment of Sewage outlined a series of some five tentative conclusions. There have been developments in the art during the past year and additional knowledge has been secured, but not sufficient to permit the drawing of final conclusions. Nothing appears to have developed that is contrary to the tentative conclusions set up last year.



SHADES VALLEY CHEMICAL SEWAGE TREATMENT PLANT AT BIRMINGHAM, ALA., SHOWING FLOCCULATOR, CLARIFIERS, AND SLUDGE BEDS

There have been few large plants actually put in operation during 1936. Of those new plants using a short period of flocculation and simple chemical treatment with lime and iron, the most important one of large size is that at Coney Island, N.Y. This plant furnished chemical treatment during the summer of 1936. It is true that certain of the facilities for chemical application and control were not in their final form, but substantial results were secured.

The experience at Coney Island emphasized the well-known fact that the results secured by plain sedimentation of a stale and highly comminuted sewage are inferior to those secured with a fresh sewage. This is likewise true of the results of chemical treatment on such a sewage; that is, the removals secured by the chemical treatment of a stale sewage are somewhat less than are commonly secured elsewhere with fresh sewages. It may be noted as a matter of interest that no difficulty whatever developed in treating the chemically precipitated sludge in the sludge-digestion tanks.

Of the plants using chemical precipitation with a return of precipitated sludge, the Shades Valley plant, in Birmingham, using mechanical agitation in the flocculators, continues to produce excellent results which are materially above those secured in plants where there is no return of sludge or subsequent treatment.

Interesting experiments were conducted at Hagerstown, Md., on plant scale, using return sludge with long periods of flocculation and with agitation by compressed air. The entire flow of this plant, which amounts to about 2.5 mgd, was treated through the four summer months from July to October, and the reported analytical results closely approached those secured by the same plant while operating as an activated-sludge plant (for which it was designed). A small installation using similar methods is now in operation at Essex Fells, N.J., where sedimentation is followed by intermittent sand filters. A larger plant of about 9 mgd capacity is practically completed at New Britain, Conn., without filters.

As a general thing throughout the country, most of the plants using chemical treatment appear to be planned for the use of chemicals on a seasonal basis only, and there seems to be a marked tendency to supplement chemical treatment by the provision of effluent filters. Notable installations of this latter type are under construction at Minneapolis—St. Paul (capacity, 134 mgd), and at Denver (capacity, 54 mgd). Smaller plants are being installed at Auburn and Elmira, N.Y., and at many other locations.

In addition, such new and reconstructed plants as those at Atlanta, Ga.; Orville, Ohio; and elsewhere are employing partial chemical precipitation in the form of moderate dosages of iron salts to effectively raise the capacity of biological units (sprinkling and slow sand filters) during seasons of heavy loading or during periods of sewer use by canning or milk-processing plants and the like. Noteworthy has been the economy and efficacy of this scheme during 1936 at Orville, Ohio. Added interest is found in the fact that industry pays the cost of the alleviating treatment required because of its wastes.

It is felt that the true evaluation of chemical treatment processes can be made only after more extended experience with some of the newer plants that are being installed. It is still too early to judge properly the relative merits of the various adaptations that are being practiced, or to fully explore latent possibilities.

Respectfully submitted,
RICHARD H. GOULD, *Chairman*

WILLIAM R. COPELAND	THEODORE R. HASELTINE
H. J. DARCEY	HARRY H. HENDON
LINN H. ENSLOW	GEORGE J. SCHROEPFER

Committee on Filtering Materials for Water and Sewage Works

ONE report of the Committee on Filtering Materials for Water and Sewage Works, on filter sand for water works, was published in the December 1936 issue of PROCEEDINGS, and it is expected that the two reports on filtering materials for sewage filters will be out shortly as Manual of Engineering Practice No. 13. There has been some recent delay in the editing of Manual No. 13 due to an active discussion of some details of the laboratory procedure for the sodium sulfate soundness test which seemed to warrant a short postponement of publication to await conclusions that are expected any day.

The committee has asked to be discontinued, as the

FLOCCULATOR, SETTLING TANKS, AND SLUDGE-PUMPING STATION AT SEWAGE TREATMENT WORKS, CONEY ISLAND, N.Y.

several members believe its effective work is done. Attention is directed to the considerable amount of effort and time devoted to this work by the several committee members. The published record of the committee activities will show that all the committee members were exceptionally interested and active. For the 15 or more official meetings of the committee, most of which included two-day sessions, 100 per cent attendance is reported.

In addition to the personnel of the committee, a great many men in the fields of water works and testing of materials, as well as practicing sanitary engineers, have contributed much time and energy towards the work of the committee.

Committee personnel comprises William E. Stanley, chairman; James W. Armstrong, W. H. Dittoe, G. B. Gascoigne, and N. T. Veatch, Jr. The report was submitted by William E. Stanley.

Committee on Salvage of Sewage Makes Progress Report

WHILE the activities of the Committee on Salvage of Sewage for the calendar year 1936 have resulted in the consolidation of much essential data to be incorporated in the final report, it has proved impossible, because of the professional activities of each of the members of the committee during the past year, to have the report ready for presentation at this meeting. It is altogether probable that a final report upon the findings of this committee can be completed during the calendar year 1937, and it is requested, therefore, that the committee be continued for another year.

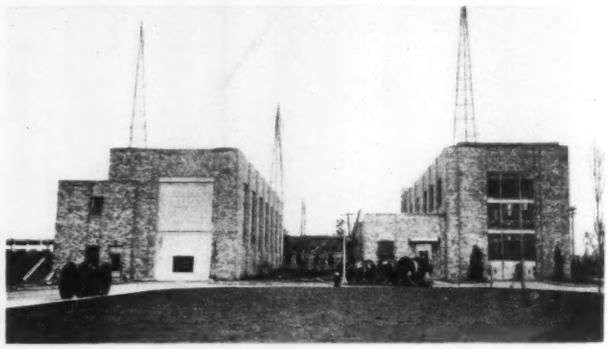
Members of the committee for 1936 were A. M. Rawn, chairman; R. R. Lyman, representing the Irrigation Division; and Earnest Boyce, R. F. Goudey, and E. A. Reinke, representing the Sanitary Engineering Division. The report was prepared by A. M. Rawn.

Committee on Sewer Rental Laws and Procedure

EXPERIENCE in New York State in endeavoring to initiate the financing of construction of sewers and sewage treatment works by sewer rents provides a definite illustration of the need for additional information on the procedure and laws under which sewer construction has been financed in the various states. In carrying out this work, the Committee on Sewer Rental Laws and Procedure should be looking forward to the preparation of recommended legislation and financing procedure with reference to the construction of sewers and treatment works by sewer rentals. This would also provide information and data of distinct value not now available to the engineering profession.

Although Chapters 225 and 678 of the Laws of New York State of 1929 authorized the financing of the construction cost of sewers and sewage-disposal plants by sewer rentals, no municipality in the state has adopted this method of financing such construction except Buffalo. A sewer authority was set up in that city last year under a special act of the legislature, under which the cost of intercepting and treating the city sewage is to be financed through sewer rentals.

One of our largest cities recently faced the necessity for financing the cost of interception and treatment of its sewage. This city considered the sewer rental method of financing with the belief that it offered a method of defraying the cost without exceeding the constitutional limit of bonded indebtedness. After careful examination of the provisions of the New York State Constitution, the law for the government of cities of its class, and after conferences with the legal division of the PWA, it was decided that the cost of construction work undertaken under the provisions of the sewer rental law be included in the constitutional debt limitations of the municipality.



SEWAGE PUMPING STATION (RIGHT) AND GRIT CHAMBER (LEFT), DISTRICT OF COLUMBIA SEWAGE TREATMENT PLANT

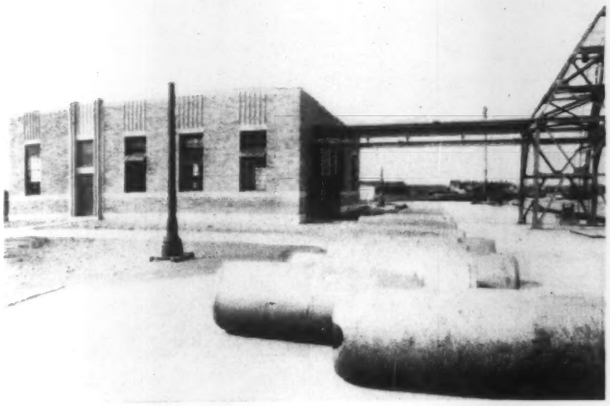
Under the provisions of Chapter 525 of the Laws of New York State of 1935, authorizing the construction of undertakings through the issuance of so-called revenue bonds, a municipality may construct a sewer system and issue bonds to finance the cost of such construction through sewer rentals. It is provided under the Act, however, that such bonds must be sold only to the U. S. Government or any agency or instrumentality thereof. This provision therefore limits the construction of sewer systems by revenue bonds to PWA projects.

It follows therefore that Federal aid under PWA must be continued or the revenue bond act amended so as to eliminate the section restricting the sale of bonds, if municipalities that are near the limit of bonded indebtedness are to be able to finance projects through some sewer-rental method.

Article VIII of the New York State Constitution provides that "no county or city shall be allowed to become indebted for any purpose or in any manner to an amount which, including existing indebtedness, shall exceed ten per centum of the assessed valuation of the real estate of such county or city subject to taxation as it appeared by the assessment rolls of said county or city on the last

assessment for state or county taxes prior to the incurring of such indebtedness; and all indebtedness in excess of such limitation, except such as now may exist, shall be absolutely void, except as herein otherwise provided . . . except that debts heretofore or hereafter incurred by any city to provide for the supply of water, shall not be so included."

Under Section 130 of the New York Village Law it is provided that "a village cannot incur indebtedness exclusive of liabilities for which taxes have been already levied and obligations issued to provide for the supply of water . . . to exceed ten per centum of the assessed valuation of real property of such village subject to taxation, provided, however, that obligations heretofore issued to pay for all or any part of the cost of paving and/or sewers which have been assessed against the property benefited thereby shall be excluded in determining such debt limitations."



CHLORINE STORAGE BUILDING AND HANDLING EQUIPMENT, CONEY ISLAND (N.Y.) SEWAGE TREATMENT WORKS

It is apparent, therefore, that there is a discrepancy between the limitations of indebtedness that can be incurred by a city and a village as regards the authority for undertaking and financing sewer construction by sewer rentals.

In spite of the difficulties that have been outlined and the disappointment caused by our inability to use the sewer rental method of financing costs of sewer disposal construction, my experience and observations during the past 20 years convince me that the adoption of the sewer rental method of financing sewage disposal costs is the most equitable method, and that when its benefits become more widely known and appreciated, it will be more generally adopted.

It therefore seems desirable that the committee prepare and submit the following data on sewer rental procedure: (1) Present methods of financing construction costs of sewers and sewage disposal works; (2) states where sewer rentals have been adopted, and tabulation of cities; (3) charges; (4) benefits and advantages of this method of construction; (5) disadvantages; (6) legal decisions on sewer rental procedure; and (7) recommended legislation for authorizing and financing sewer construction by sewer rentals.

The members of the Committee on Sewer Rental Laws and Procedure are Earl Devendorf, chairman; J. A. Tobey, adviser; and Howard R. Green, W. D. Hatfield, Leon B. Reynolds, and Frederick H. Waring.

Metcalf and Eddy

SKETCH OF WATER-PURIFICATION PLANT, CITY OF LAWRENCE, MASS.

Committee on Technical Aspect of Refuse Disposal

THIS IS the second report of the Committee on Technical Aspects of Refuse Disposal. Its first report, printed in CIVIL ENGINEERING for March 1936, contained definitions of refuse materials and a statement of the status of refuse disposal in the United States and in Europe. This report will outline some of the developments in the field in the past and will point out some items which could be improved. While developments will generally be limited to the technical aspects, there are some features of general interest which should be touched on.

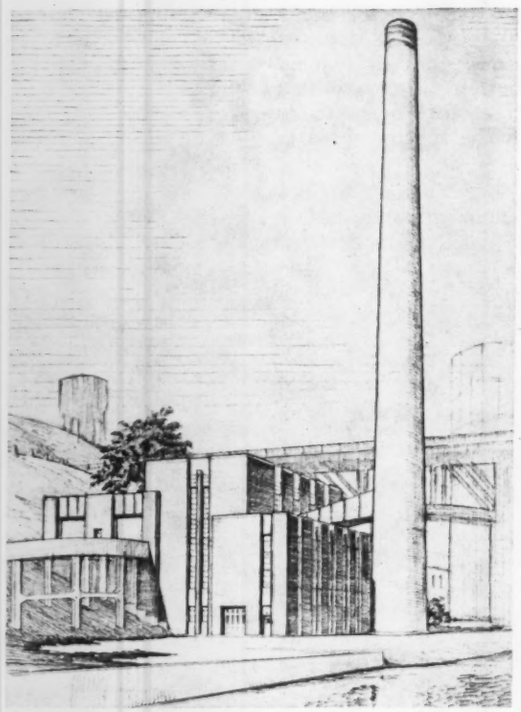
Perhaps the most spectacular recent development in the field is the utilization of the mountainous ash and rubbish dump on the Flushing Meadows as a site for the New York World's Fair (to be held in 1939). This accumulation of the refuse of many years from Brooklyn and Queens is being leveled off and spread over nearly 800 acres of marsh land at a rate of more than 40,000 cu yd per day. An interesting account of this great material-moving enterprise was given in *Engineering News-Record* for October 22, 1936. A kindred activity on a very much smaller scale is the grading of dumps and their conversion to park areas, which has been carried on rather extensively in many municipalities, principally as a means of creating employment. This work is of importance as a sanitary measure, and as a means of improving the appearance of our municipalities, particularly of their approaches.

In *The American City* for December 1936, is given a tabulation of the per capita costs of sanitation service in 94 cities with a population of more than 100,000. The statistics, which include figures for refuse collection and

disposal, are taken from a report recently released by W. L. Austin, director of the Bureau of the Census, U. S. Department of Commerce. While such a tabulation is interesting, great care should be exercised, in comparing the costs in one city with those in others, to take into account differences in the character and thoroughness of the services performed, in particular, the kinds of materials collected and disposed of, the frequency of collection, the topography, the layout of streets, the length of haul, and the method of disposal.

The experience of San Francisco in disposing of garbage, rubbish, and ashes during the last four years, described in *Engineering News-Record* for February 27, 1936, is illustrative of the possibilities of sanitary fill where the work is adequately directed and sufficient money is spent for effectively covering the refuse with earth, not only on the top but on the sides as well, thus enclosing it in an earth cell. In this case an adjacent hill provided material for the earth cover. Refuse is delivered by the train load, and the cover is handled by dragline cranes, power shovels, trucks, and bulldozers, a substantial amount of mechanical equipment being used. Fly and rat nuisances are said to have been overcome by the effective covering of the material on the top and sides each day. The fire hazard has been controlled by an earth seal and the saturation of the material with water vapor, resulting from hosing down during the unloading of the cars. The drainage from the fill during the rainy season is reported to have an exceedingly disagreeable odor. In this case it is said to be diluted immediately by the waters of the bay, but this item might require special consideration in other municipalities where such dilution is not practicable. In the neighboring city of Berkeley, Mr. Goodridge reports that, except for wet garbage the fill-and-cover method has been used since 1923 with satisfaction. Here, however, the rat nuisance is "abated by poisoning."

Hog feeding has become of more importance as a means of garbage disposal owing to the current high price of corn and pork. The City of Los Angeles has recently received bids for a three-year contract for disposal by hog feeding of about 10 per cent of its garbage, which is collected by city trucks and brought to a central transfer station. The contractor's bid was based on a price of $1.11 per ton for residential-type garbage, with hog prices ranging between 9 and 11 cents per lb in the local market, the sale price of the garbage varying with the price of hogs. Under the proposed contract, the contractor would pay nothing with hogs selling for less than 5 cents per lb, 30 per cent of the base price with hogs selling between 5 and 7 cents, 65 per cent from 7 to 9 cents, 100 per cent from 9 to 11 cents, 135 per cent from 11 to 13 cents, 170 per cent from 13 to 15 cents, and 225 per cent for more than 15 cents. In the fiscal year ending June 30, 1937, the City of Los Angeles will receive an income of about $175,000 for its garbage, or slightly more than 90 cents per ton.



Metcalf and Eddy

INCINERATOR AND 1,000-HP BOILER PLANT FOR ROCHESTER, N.Y.
Scheduled for Completion During 1937

In St. Louis, grinding of garbage and its discharge with sewage into the Mississippi River continues at the first station, which was put in operation early in 1935, and four new grinding stations are now either in service, under construction, or contemplated. At Durham, N.C., grinding garbage and treating it with sewage continues, but no new installations have been reported.

Use of individual household-garbage grinders has been approved by some city engineering departments and not approved by others. Even with greatly reduced prices made possible by mass production, it is doubtful whether the number of such units installed will greatly influence the problems of sewage-plant operators in large cities. But in some of the small, wealthy suburban communities they may become a factor of importance.

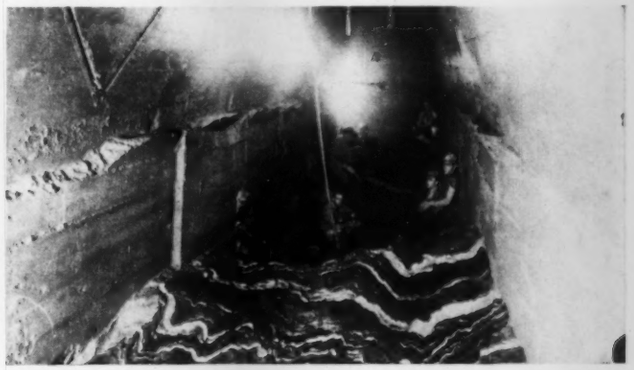
The trend in garbage reduction is towards simplification of process, with less attempt at high recoveries where it is likely that the revenue from the additional recovery may not justify the cost. Much tankage was burned as fuel under boilers or disposed of by filling waste land during the period of low prices resulting from the recent economic depression. At the present time there is a good spot market for tankage.

Rochester, N.Y., will discontinue operations at its rubbish salvage plant when the new steam-generating incinerator is completed in 1937, thus adding another city to the list of those which have abandoned this process.

In the early days of incineration many plants were intended primarily for burning garbage, and little consideration was given to providing the necessary fuel to maintain continuously a deodorizing temperature. In

SEWAGE-TREATMENT WORKS, METROPOLITAN DISTRICT OF HARTFORD

those days it was not uncommon for garbage incinerators to cause objectionable odors. Since the necessity of maintaining deodorizing temperatures has been clearly understood, as well as the inability to do this unless sufficient heat value is present in the material being burned, there have been few cases of objectionable odors unless caused by failure to operate reasonably.



CONSTRUCTING CORE WALL, MAIN DAM OF QUABBIN RESERVOIR

General View of Trench, Looking East

Inside the Working Chamber of a Caisson Core Wall

In later years more consideration has been given to the structural details of furnace design, with the result that maintenance has been reduced and the life of furnaces increased. The design of refuse furnaces has approached more closely that of boiler furnaces and, as sound mechanical engineering details have been emphasized, the design of the plant has improved.

Substantial reductions have been made, not only in the amount of hand labor required in operation, but in eliminating some of the more objectionable phases of such labor. Probably the greatest improvement in this direction has been in charging facilities. Formerly most plants were charged by hand, while now most large plants are crane-fired, as are also many of the small ones. On the other hand, in localities where labor is always cheap and plentiful, some large plants have been designed for hand charging, but the design has occasionally been such that the operations of dumping and charging are segregated, thus increasing the safety and comfort of the charging men and minimizing the disagreeableness of handling raw garbage. A recent development in charging equipment is the use of electric gear motors and clutches in place of air rams.

In the handling of the ashes, labor has been reduced and working conditions improved. Until a few years ago ashes were customarily raked from the grates directly on to the stoking floor. Clouds of hot dust and disagreeable smoke filled the stoking room on such occasions. Frequently the ashes were quenched on the floor by spraying water over them with a garden hose, with consequent clouds of steam. An attempt was made to improve this condition by providing large ventilating hoods, connected with the forced-draft fans, across the front of the furnaces. Later dumping grates were provided by means of which the ashes were dropped into ash pits below the stoking floor, for subsequent removal into wheelbarrows or cars in an ash tunnel or basement. While this reduced the arduous labor in the stoking room and improved the working conditions there, it merely transferred the disagreeable conditions from an otherwise well-ventilated stoking room to what was generally an ill-ventilated basement.

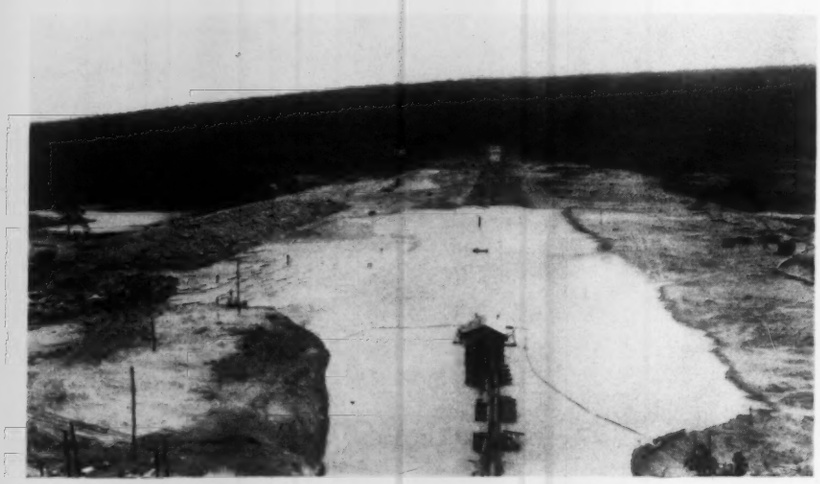
The next improvement came in providing quenchers in each ash pit, either for continual or intermittent use, with water-sealed gates, which permitted reasonably high forced draft without blowing smoke into the ash tunnel. With the water-sealed gates, provision has been made for operating the gates either by oil rams or, in the smaller plants, by hand-ratchet wrenches. Substitution of ash trucks operated by electric motors, running in the tunnel from the pits to a skip hoist reduced the labor required in the ash tunnel and increased the rate at which ashes could be handled through the plant. Frequently this is now accomplished by driving motor trucks directly through the ash tunnel and loading them, as they pass under each ash pit, by merely opening the gate and letting the ashes fall from the pits above into the truck, thus saving rehandling.

In plants burning very dusty fuel, such as mixed refuse or rubbish with a large percentage of household ashes, consideration is being given to the elimination of dust from handling the refuse in the receiving bin. In order to secure the storage volume required, it frequently is necessary to provide deep bins and, as the refuse falls through a great distance, clouds of dust rise to the charging floor. Provision is being made in designs by the Department of Sanitation in New York City and elsewhere, for capturing this dust at the top of the bin wall. Controlling this dust, however, is not a simple matter where the length of bin is great and the space through which the material is dumped is high. This is one feature of plant design which deserves careful study.

For a number of years records of combustion-chamber temperature have been kept in many plants. Frequently, however, no use is made of these records, even in controlling the temperature of the fires, because it is so simple to tell without instruments the temperature that is being maintained. Recently automatic temperature control, in addition to indicating and recording equipment, has been installed in a few plants, as at Washington, D.C., and Newton, Mass. In the plants mentioned, this has been obtained by controlling the admission of secondary air. In the new Rochester plant, provision is being made for automatic control of the main dampers as well.

In several plants built about 1907, boilers were installed for utilizing the heat from combustion of refuse. These plants performed satisfactorily for many years, most of them up to the present time. One of them has recently been enlarged and continues to sell its steam to the local public utility. At the Providence plant, recently completed, waste-heat boilers operating at a little more than 200-lb pressure, generate electricity

which is used in the adjacent activated-sludge sewage-treatment plant and for pumping sewage. The Manchester, N.H., plant, now under construction, is provided with a boiler capacity of about 11,000 lb of steam per hour, for use in the adjacent asphalt plant, at a pressure of 150 lb. At this writing (January 1937) New York City is said to be negotiating with a private concern for the sale of steam from one plant, now under construction, for which the annual charge will be in the neighborhood of $200,000.



THE DIKE OF QUABBIN RESERVOIR WAS CONSTRUCTED BY HYDRAULIC METHODS

The Rochester incinerator will generate at peak load about 50,000 lb of steam per hour, for use in the adjacent garbage reduction plant. The boilers are designed for 250-lb pressure, and it is expected that surplus steam may be sold to the Rochester Gas and Electric Company, whose generating plant is adjacent to the garbage plant. (The city of Rochester now purchases steam from the company.) In order that the production of steam at the incinerator may always be synchronized with the demands of the reduction plant, auxiliary oil burners are being provided under the boilers. Burners also are being provided on the furnaces themselves, to facilitate combustion when the refuse is extremely wet.

Chimney design has been greatly modified in recent years. When maintaining high temperatures of combustion in plants in which the flue gases are not cooled by passing through boilers, it is necessary to line chimneys with refractory materials. With the frequent wide changes of temperature in the gases, it has been found advisable with independently supported linings to provide a wrought-iron corset. In addition, a renewable target wall for the bottom part of the chimney is commonly provided. In the plant at Charleston, S.C., a refractory lining has been used, supported sectionally on the radial-brick chimney shaft. In this case the greatest thickness of lining is a single $4\frac{1}{2}$-in. course of firebrick.

It is said that a multiple-hearth incinerator is being constructed at Kokomo, Ind., to burn a mixture of sewage sludge and ground garbage. Several other such plants are said to be contemplated.

The original instructions to the Committee on Technical Aspects of Refuse Disposal requested consideration of the engineers' status in refuse-disposal matters. Sanitary engineers have had relatively little to do with refuse disposal in the past. Probably there are more problems of sanitary engineering involved in disposal by hog feeding, bacterial fermentation, dumping at sea, sanitary fill, grinding and discharging into rivers or sewage treatment plants, or in any of the other miscellaneous processes than in incineration. Direction, or at least supervision, of the operation of these processes might well be done by sanitary engineers, and the design of any works for these miscellaneous processes might well be made or at least approved by sanitary engineers, since the handling of an unstable organic material may result in offensive conditions if sanitation is not duly considered.

Until a few years ago incinerators for municipal refuse were designed and constructed almost exclusively by contractors. Now, specifications for their design and construction by competing contractors are prepared more frequently than formerly by sanitary engineers. A few plants recently have been designed by consulting engineers and in the case of New York City, by the engineering staff of the commissioner of sanitation. However, the detailed design of incinerators involves only a few fundamental sanitary-engineering principles. This is primarily a matter of mechanical engineering, structural engineering, and architecture, kindred to steam power-plant design.

Again, as reported in January 1936, most of the incinerator construction or enlargement in 1936 has been financed in part by the Federal Emergency Administration of Public Works, or by WPA and its predecessors.

There appears to be more interest today in the construction of incinerators than there has been for some time, although it is probable that if no further financial aid were to be given by the federal government, many of the contemplated projects would be postponed.

Respectfully submitted,

HARRISON P. EDDY, JR., *Chairman*

HERMAN G. BAITY — WALTER N. FRICKSTAD
HERMAN P. CORTELYOU — HARRY GOODRIDGE
FRANK E. DEMARTINI — FRANK C. TOLLES
LEON G. WILLIAMS

Committee on Water Treatment Research and Plant Design Makes Progress Report

THE COMMITTEE on Water Treatment Research and Plant Design is able only to report progress on its work. The monographs which will constitute the basis for the manual have not yet all been received by the chairman owing to changes in personnel and to the length of time which members have found necessary to prepare monographs on the subjects assigned to them.

As soon as all monographs have been received, it is the chairman's purpose to revise them for duplication of subject matter and to combine them for the first draft of the manual. This tentative draft will then be submitted to each member of the committee for criticism. A final draft of the monograph may then be prepared for submission as the committee's report to the Division.

Members of the committee are Joseph W. Ellms, chairman; James W. Armstrong, Joseph D. De Costa, Arthur E. Gorman, George W. Hamlin, Eugene A. Hardin, Aaron G. Levy, Arthur L. Reeder, and F. H. Stephenson. This report is by Joseph W. Ellms.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Eliminating Trial and Error in Backwater Computations

By R. L. IRWIN, JUN. AM. SOC. C.E.
U. S. ENGINEER OFFICE, HUNTINGTON, W.VA.

COMPUTATION of backwater profiles, based on Manning's formula, can be simplified by the following graphical method, which eliminates trial and error and is both fast and accurate.

The basic formula may be written as

$$AV = Q = \frac{1.486AR^{\frac{2}{3}}S^{\frac{1}{2}}}{n},$$

in which the nomenclature needs no explanation.

Now let L = length of a reach in feet
h = difference of water surface elevation between the ends of the reach, in feet
$h_m = h/2$

Then S can be replaced by $2h_m/L$, and the formula can be solved for h_m:

$$h_m = \left[\frac{Q}{\frac{1.486AR^{\frac{2}{3}}}{n\,(L/2)^{\frac{1}{2}}}}\right]^2$$

The denominator, $\frac{1.486AR^{\frac{2}{3}}}{n\,(L/2)^{\frac{1}{2}}}$, is a constant for any given water-surface elevation in a reach, and is hereafter designated as K. As the first step in the backwater study, values of K are computed for each reach for various water-surface elevations, and from these data a set of curves similar to Fig. 1 is plotted. An ordinate scale of 1 in. = 1 ft will frequently be found satisfactory for this purpose. Now if a sufficient number of K values are projected from the curve onto the elevation scale, a type of nomograph is formed, from which the value of K for any elevation can be determined by interpolation. The original curve has now served its purpose and plays no part in what follows.

To expedite calculations, a sliding scale (Fig. 2) is next constructed from the formula $h_m = (Q/K)^2$. The ordinates are values of h_m, and must be to the same scale as the ordinates of Fig. 1. Each of the sloping lines of Fig. 2 corresponds to a particular value of K. For a reason which will later be clear, each line is referred to a separate origin of coordinates, and the values of h_m are measured downward, instead of upward, from them. These origins are ranged along a vertical line, and for convenience are spaced about 0.1 in. apart. By making the abscissa scale a square scale—that is, by placing the vertical lines corresponding to Q values of 1, 2, 3, and 4

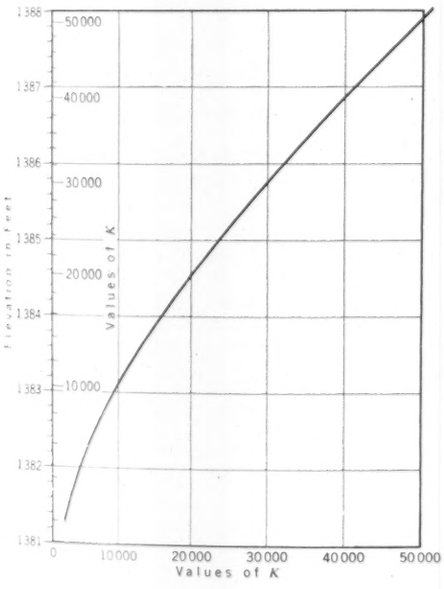


FIG. 1. THE K SCALE FOR A TYPICAL REACH, AND CURVE FROM WHICH IT IS DERIVED

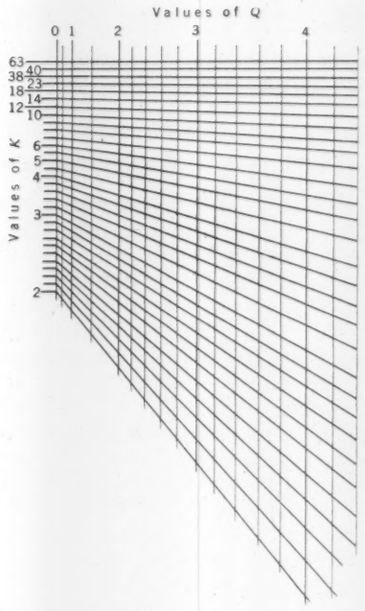


FIG. 2. THE SLIDING SCALE (TO BE PLOTTED ON CELLULOID)

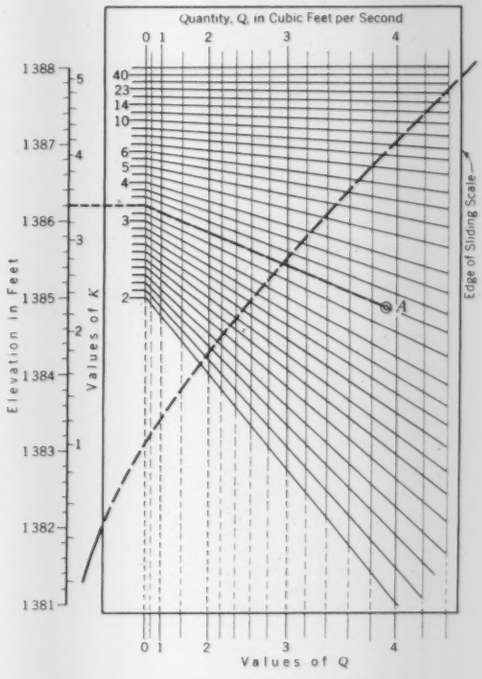


FIG. 3. THE SLIDING SCALE (FIG. 2) SUPERPOSED ON FIG. 1

at distances of 1, 4, 9, and 16 units, respectively, to the right of $Q = 0$—the parabolic K curves become straight lines, and each of them is completely determined by computing one point. For example, to plot the line for $K = 2$, we may compute the value of h_m for $Q = 4$. It is 4. Then the $K = 2$ curve intersects the $Q = 4$ line 4 in. below the origin for this particular curve, and a straight line can be drawn immediately from this origin to the computed point.

When sufficient K curves have been plotted in this manner, the chart (Fig. 2) is transferred to a piece of transparent material such as celluloid. It is important to note that this one sliding scale can be used for any reach.

It should also be noted that the indicated values of Q can be multiplied by any number whatever, provided the indicated values of K are multiplied by the same number. In other words the $K = 2$ line is also the $K = 20{,}000$ line, provided the indicated values of Q are all multiplied by 10,000.

The next step is to assemble the Fig. 1 charts for the various reaches, and transfer the vertical lines of Fig. 2 to each. These lines bear no relation to the parabolic curve of Fig. 1 (which it will be recalled is no longer of any significance) and can be placed at any convenient distance to the right of the elevation scale.

All necessary diagrams are now ready for use. Let us assume that the water surface elevation at the lower end of the reach corresponding to Fig. 1 is 1,384.9 when the flow is 39,000 cu ft per sec. What is the elevation at the upper end of the reach?

The use of the diagrams is illustrated in Fig. 3. The point A has been plotted on the reach chart at ordinate 1,384.90 and abscissa 3.9. Since 3.9 is one ten-thousandth of the actual flow, the values of K have also been divided by 10,000. The sliding scale is now placed over the reach chart, with the Q-scales corresponding, and moved vertically. In this manner the various values of K marked on the left edge of the sliding scale are successively brought opposite corresponding values of K on Fig. 1. There is only one K line on the sliding scale that will pass through the point A at the same time that that particular value of K on the left of the sliding scale is in alignment with the same value of K on the fixed scale. Thus in Fig. 3, the K value of 3.4 on the sliding scale is adjacent to $K = 3.4$ on the fixed scale, and the $K = 3.4$ curve of the sliding scale passes through point A. The elevation at the center of the reach is the elevation corresponding to this value of K, or 1,386.20. Then $h_m = 1.3$, $h = 2.6$, and the elevation at the upper end of the reach is 1,387.50. A careful solution by trial and error gives 1,387.53. If very accurate results are required, the result given by the sliding scale can be used for the first approximation, and refined by computation.

It is quite often necessary to interpolate values between the K curves, which is one reason for keeping these curves apart and using a Q scale such that the curves are straight lines.

The main purpose of the sliding scale is to save time in the actual construction. However, if backwater is to be computed for a number of different values of Q, it may be convenient to omit the sliding scale and draw the K curves directly on the various reach charts. In this case the origin for each K curve is placed adjacent to the corresponding value of K on the elevation scale. Since the values of K now correspond by construction, the answer can be read directly as soon as point A is plotted. A little practice with this method will assure fast and accurate results.

Discharge Area of Circular Gates

By I. NELIDOV, ASSOC. M. AM. SOC. C.E.

SENIOR ENGINEER OF HYDRAULIC STRUCTURE DESIGN, STATE DEPARTMENT OF PUBLIC WORKS, SACRAMENTO, CALIF.

BY means of Fig. 1, the discharge area of a circular gate at partial openings can easily be computed. The basic formula is $A = CR_0^2$, in which A is the area sought; R_0, the radius of the pipe; and C, a coefficient that depends upon the degree of opening and the ratio between the radii of the pipe and the gate itself. This ratio is designated as n. The abscissae of the diagram are values of $p = h/2R_0$, where h is the height of opening along the center line.

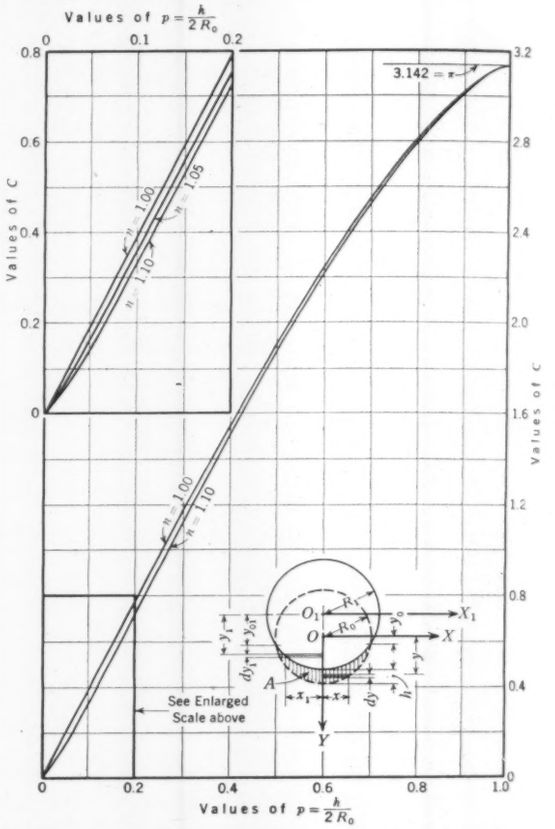


FIG. 1. CURVES FOR DETERMINING THE AREAS OF GATE OPENINGS

Example: Find the area of opening in a 24-in. pipe when the gate is 6 in. above the invert. The radius of the gate is 13.2 in.

Solution: $n = 13.2/12 = 1.1$; $p = 6/24 = 0.25$. From the diagram, $C = 1.31$. Then $A = 1.31 \times 1^2 = 1.31$ sq ft.

With nomenclature as indicated in the diagram, the development is as follows:

$$A = 2\left[\int_{y_0}^{R_0} \sqrt{R_0^2 - y^2}\,dy - \int_{y_{01}}^{R_1} \sqrt{R_1^2 - y_1^2}\,dy_1\right] =$$

$$R_0^2\left[\frac{\pi}{2}(1 - n^2) - k_0\sqrt{1 - k_0^2} + k_1\sqrt{n^2 - k_1^2} - \sin^{-1}k_0 + n^2\sin^{-1}\frac{k_1}{n}\right] = CR_0^2$$

In the evaluation of the integral, R_1/R_0 has been replaced by n, y_0/R_0 by k_0, and y_{01}/R_1 by k_1. To determine C for any value of h, k_0 and k_1 must be obtained by two conditions: $R_0^2 - y_0^2 = R_1^2 - y_{01}^2$, and $R_0 - y_0 = R_1 - y_{01} + h$, which are evident from the sketch.

Designing Stable Channels and Computing Bed-Load Movement

By JOHN HEDBERG, JUN. AM. SOC. C.E.
FREEMAN SCHOLAR, 1936–1937

SINCE 1932 Prof. E. Meyer-Peter and his associates at the Versuchsanstalt für Wasserbau of the Federal Technical University, Zurich, Switzerland, have been conducting many experiments relative to the movement of bed-load material. Their efforts have resulted in the formulation of the following equation:

$$\frac{q^{3/5} f}{d} = a + \frac{b G^{3/5}}{d} \quad \ldots\ldots\ldots\ldots [1]$$

Where q = quantity of flow per unit width of channel
f = friction slope of the stream
d = diameter of bed-load material of which 35 per cent by weight of a characteristic sample is smaller
G = quantity of transported bed material per unit width of channel per unit of time
a and b = constants depending on the specific gravity of the bed-load material and the units employed. (If q and G are taken in cu ft per sec per ft of width, and d is in feet, then $a = 0.253$, and $b = 0.756$ for a bed load with a specific gravity of about 2.6.)

In two published papers, "Neuere Versuchsresultate über den Geschiebetrieb" by E. Meyer-Peter, H. Favre, and A. Einstein (in *Schweizerische Bauzeitung* for March 31, 1934); and "Beitrag zur Berechnung der Geschiebeführung und der Normalprofilbreite von Gebirgsflüssen," by E. Meyer-Peter, H. Favre, and R. Müller (in the same publication, for March 2, 1935), are given a description of the experiments and proposals for the utility of their findings. The following paragraphs are in the nature of a review of these papers, but are in no sense a translation. The numerical example is entirely new, and my method of calculation conforms only partly to the authors' suggestions.

Although Eq. 1 has received excellent verification from a multitude of experiments not only at Zurich but also by Gilbert in America, it is strictly limited to the solving of two-dimensional problems. The three-dimensional flow of natural, meandering streams with the phenomena of bank cutting is another problem entirely. Also it must be clearly understood that Eq. 1 applies only to bed-load material of appreciable size ($^1/_8$ to 2 in. in diameter) and not to fine silts or such material as may be carried in suspension. Indeed, experiments with fine sand show that a somewhat different law applies for it. On the other hand, the experimenters found that Eq. 1 holds very well over a wide range of specific gravity with changes only in the constants a and b. That the law should be applicable for such light material as brown coal is very gratifying from the standpoint of model testing.

Furthermore, if both sides of Eq. 1 are divided by $g^{3/5}$ (g = acceleration of gravity), the resulting equation is non-dimensional and in perfect agreement with the Froude law of similarity. Since the Froude number is a measure of turbulence, Eq. 1 says that the quantity of transported material is merely a simple function of the turbulence of the stream. This is a relation that intuition would lead us to expect.

Perhaps the most convenient use of the Meyer-Peter formula is for the special case of $G = 0$, when no bed movement takes place. Equation 1 then reduces to

$$\frac{q^{3/5} f}{d} = a \quad \ldots\ldots\ldots\ldots\ldots [2]$$

Used in conjunction with the Manning or Kutter formula, this relationship completes the conditions necessary for the design of a stable channel of any type. A typical problem will illustrate the procedure.

Let it be required to design a trapezoidal channel with side slopes $1^1/_2$:1 to carry 100 cu ft per sec on a slope of 0.002, such that a bed load of characteristic diameter 0.03 and a specific gravity of 2.6 will be in equilibrium. Assume Manning's $n = 0.025$.

From Eq. 2, $q_m = 7.38$, where q_m is the maximum permissible value of q. Introducing a constant k (related to Manning's n) for convenience,

$$q = kAR^{3/5} f^{1/2} = kf^{1/2} y^{3/5}$$

$$Q = \int q dx = kf^{1/2} \int y^{3/5} dx$$

An integration over the area of a trapezoid of side slope m:1 gives

$$Q = kf^{1/2} \left(by_1^{3/5} + 2m \frac{y_1^{3/5}}{8/3} \right)$$

where y_1 is the center depth. It follows that

$$Q = q_m (b + \frac{3}{4} m y_1).$$

Substituting known values,

$$b = 13.55 - \frac{9}{8} y \quad \ldots\ldots\ldots\ldots [3]$$

The Manning equation gives

$$AR^{3/5} = \frac{Qn}{1.486 f^{1/2}} = \frac{100\ (0.025)}{1.486\ (0.002)^{1/2}}$$

or

$$(by_1 + my_1^2) \left(\frac{by_1 + my_1^2}{b + 2y_1 \sqrt{m^2 + 1}} \right)^{3/5} = 37.6 \ldots [4]$$

Solving Eqs. 3 and 4 by trial gives $y_1 = 2.0$ ft, $b = 11.3$ ft. The mean velocity in the center vertical is therefore

$$V_m = \frac{q_m}{y_1} = \frac{7.38}{2} = 3.69 \text{ ft per sec}$$

It is quite apparent that this problem could have been solved with equal ease for the case of the transportation of any given amount of bed load.

In the second of the two papers, Meyer-Peter and his associates explain the use of their formula for calculating bed loads in natural streams and for designing the regulation of such streams for given bed loads. In either case it is necessary for a sufficient control stretch to exist in the stream so that satisfactory measurements can be made of discharge, slope, and cross section. Assuming these to be known, the quantity of material shoved along the bottom may be readily calculated with the aid of Eq. 1. On the other hand, if the quantity of transported material and the discharge are known, it is presumably possible to adjust the cross section and the slope to produce a stabilized flow.

This latter case is infrequent, however, because of the inconvenience in determining the bed load. Difficulty in making measurements that may be relied upon occurs not only because of the movement of the material in banks, making any short-time observation very uncertain, but also because of the uncertain behavior of

catch buckets. As might be expected, whenever any obstruction is placed in a stream—even a screened bucket—the bed load is diverted. Experiments in progress at the laboratory at Zurich show bucket efficiencies of the order of 40 per cent, and sampling that is favorable at times to the coarse material and at other times to the fine. In view of these things it is more practical at present to determine the transportation of bed material from its accumulation in reservoirs and deltas.

It is to be hoped that anyone having data available on any natural or artificial channel will not fail to test Eq. 1 with it. Although the theory seems to be well substantiated in the laboratory there is an urgent need for verification from nature.

Determining the Meridian Without Clock or Ephemeris

By LEONARD C. JORDAN, M. AM. SOC. C.E.
CONSULTING AND DESIGNING ENGINEER, NEW ROCHELLE, N.Y.

DETERMINATION of the meridian by observations upon fixed stars other than Polaris seems to be generally overlooked in surveying tests. However, when other methods fail, through lack of facilities or because the latitude and longitude of the place of observation are not known, a knowledge of this method may prove helpful. I once found good use for it years ago when on a railroad location job in Bolivia with C. A. Bock, M. Am. Soc. C.E.

There is no "South Star" corresponding to Polaris. We had no ephemeris, nor could we have used one, since we did not know the correct time or the exact latitude and longitude of our set-up. The method employed for determining the meridian, however, was simple and accurate, though it was an all-night job.

The transit was set at zero upon an illuminated stake located to southward, and was then sighted upon stars rising in the southeastern sky. (It should be remembered that we were in the southern hemisphere.) The horizontal and vertical angles were recorded for each observation. A corresponding sight was taken upon each star as it was setting in the west, with the instrument set at the same vertical angle as recorded for the easterly observation. For a single pair of observations, using the same vertical angle, a star was as far west of the meridian at the second sighting as it was east of the meridian at the first. Hence half the difference of the observed horizontal angles was the angle between the line to the reference stake and the true meridian.

A few of the stars were chosen unwisely and did not descend in time for the second observation. However, we secured about twenty independent pairs of observations. Approximately half of the pairs were in exact agreement. Some of the others indicated the meridian a half minute or a minute to westward, and the remainder a similar angle to eastward.

This method requires no correction for refraction, since each determination of the meridian is obtained by a pair of sights at the same vertical angle. Furthermore, it eliminates some of the errors due to inaccuracies of the instrument. For instance, if the vertical angles are incorrect, yet equal, the results will still be correct.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

"Wise and Otherwise" Problems Found Stimulating

DEAR SIR: Believing that many others besides myself find the "Wise and Otherwise" column a very agreeable feature of CIVIL ENGINEERING, I feel that we should express our appreciation and our desire for the continuance of this feature. Difficult problems are constantly arising in engineering practice, and quite often their solution calls for ingenuity and resourcefulness rather than new knowledge or tools.

One of the greatest assets an engineer can possess is the ability to separate the essential features of his problems from the insignificant ones, thus simplifying his work and shortening his labors, and often eliminating apparent difficulties. He is doubly fortunate if he can scrutinize his answers and say with certainty that the governing quantities are all there and that there are none of the other kind. The problems thus far presented in "Wise and Otherwise" have not called for unusual mathematical or technical knowledge nor for unfamiliar methods, but they certainly have called for clear thinking. In this sense I think they have been agreeably stimulating and have served a definitely useful purpose.

EDWARD L. INGRAM, M. Am. Soc. C.E.

Nyack, N.Y.
February 1, 1937

Editor's Note: The column "Wise and Otherwise" was initiated in January 1936, on a somewhat tentative basis. While the accompanying appreciative letter is the first of its kind to be published herein, a gratifying number of communications on the same subject have been received from members during the past year. In view of the interest thus evidenced it is believed that the column has demonstrated its right to be made a continuing feature.

Safety of Oil Tanks in Floods

TO THE EDITOR: Accounts of floods have focused attention on one phase of the New England and Midwest disasters that I believe merits consideration by engineers. Newspaper accounts, radio broadcasts, and pictures—all have mentioned the danger of drifting oil tanks, menacing bridges and all structures in their path.

It is readily recognized that tanks, above ground and underground, vertical and horizontal, are designed carefully for overturning and the usual foundation loadings. However, there is no provision made for buoyancy or uplift and, since these tanks are always located in the cheapest and lowest land, they are bound to be in the path of every flood.

It seems therefore that engineers of the various gas and oil companies ought to embody in their designs some provision for buoyancy to prevent these tanks from endangering other property. A flood is an unforeseen, improbable, and unpredictable event, but it does seem possible to provide flap valves or some similar attachment to prevent entrapment of air and consequent buoyancy.

Another important provision would be the prevention of the release of oil on flood waters. At present, I do not see any economical or feasible solution for this particular difficulty.

JAMES B. MORELAND, Assoc. M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
February 10, 1937

Engineers Not Responsible for Economic Problems

DEAR SIR: In the December issue, J. K. Finch, M. Am. Soc. C.E., in his article on "The Social Responsibilities of the Engineer," refers to the erroneous idea that it is the engineer who is responsible for many of the perplexing economic and social problems that confront us. As a matter of fact, the engineer has solved many more social problems than he has created. Early in the eighteenth century, before the birth of James Watt, presumably the originator of "technological unemployment," the unemployment situation in England, with a population of 5,500,000, was much worse than it is today with a population of 37,000,000. On this point, George Macaulay Trevelyan, in his recent history of Queen Anne's reign, says:

"In Anne's reign the parish provision for the poor chargeable on the rates was being very generally supplemented and softened by the establishment of almshouses through private benefaction.... But besides private beneficence, public policy, financed out of the local rates, was constantly establishing new workhouses and enlarging the 'parish stock' of materials to give employment. When Anne came to the throne almost a quarter of the population was occasionally in receipt of parochial relief, and the poor rate stood at about £800,000 per year."

As to the conditions in France, Mr. Trevelyan says: "Lady Mary Wortley Montagu noticed on her travels in France in 1718 'When the post-horses are changed, the whole town comes out to beg, with such miserable starved faces, they need no other eloquence.' "

In reading the Old Testament, we find that there were poor and needy even in those pastoral days, and the prophet Amos denounced those who "oppress the poor," "crush the needy," "afflict the just," "take a bribe," and "lie upon beds of ivory" as fiercely as a certain present-day religious zealot denounces those who, it would seem, are repeating the iniquities inveighed against by Amos three thousand years ago.

PHILIP W. HENRY, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
January 28, 1937

Malaria Control in Mississippi

DEAR SIR: In connection with the article by J. A. Le Prince, in the July 1936 issue, I should like to comment on malaria in Mississippi. The incidence of the disease in this state is not uniform. The principal malaria problem is encountered in the northwestern part of the state, which is the delta. In 1915, there were 1,492 deaths from this disease, while in 1935 the number decreased to 518. During the last few years, the mortality rates varied from 0.0 in a few of the southern counties to 139.0 per 100,000 population in a delta county.

A comprehensive malaria-control program, inaugurated in the delta in 1929, is still in effect. This program was designed to drain small breeding areas of the *Anopheles quadrimaculatus* mosquito (malaria vector) located in cities or thickly settled communities. One feature of the program was the promotion of the use of screens. From the beginning, emphasis has been placed on educational work, and it is probable that this has borne more fruit than any other part of the program.

Since the inauguration of the federal-relief programs, the State Board of Health has utilized relief labor for draining or filling swamps that constituted a menace to the public health. This labor has been utilized in 70 counties and 196 towns. At first, engineers and public officials showed little or no interest in this type of work. The engineering profession, in the past, has been guilty of creating faulty drainage structures along public highways, railroads, and levees, which in later years constituted real health hazards. However, in recent years public officials and the engineering profession, in particular, have manifested a spirit of cooperation with and interest in the different phases of our program. At the present time, the State Highway Department and all railroads are cooperating with Public Health Officials in every way possible to promote better drainage along their road-beds. The specifications of the Mississippi State Highway Department call for the complete drainage of borrow pits wherever possible.

Filling is the ideal method of malaria control, as no maintenance is required. During the past eight years, many towns have utilized garbage, trash, and other debris to fill in ponds which are located within their corporate limits and would have been difficult or impossible to drain. Town officials are particularly pleased with this method, since it reduces hauling costs and eliminates mosquito breeding areas.

The practicability of malaria control was illustrated by Mr. Le Prince when he pointed out that the sick rate for malaria in the army cantonments during the World War was only one-half of one per cent of that in the Spanish-American War, even though many army camps were located in malarious sections.

It is interesting to note that Americans have been the last to make use of the valuable contribution made to malaria control by Gorgas and Le Prince in their work in Panama. They constructed concrete ditches thirty years ago, and in a very short time the British Government was using permanent ditches similar to those constructed in Panama in the far corners of the British Empire. Thirty years later, we are beginning to make use of them in America.

We are now constructing permanent lined ditches in twenty-five towns, and this work is becoming very popular. An experiment in the use of rock asphalt, liquid asphalt, and cotton reenforcing material for this permanent lining is being conducted. It is too early to predict whether or not it will be successful.

I visualize a great era of prosperity in the South as a result of the influx of industries, particularly if the engineers "build malaria out" by taking steps to promote and preserve the health of the general public.

NELSON H. RECTOR, Assoc. M. Am. Soc. C.E.
Assistant State Director, Malaria Control
State Board of Health

Jackson, Miss.
January 29, 1937

TYPICAL MOSQUITO-BREEDING AREA IN COLUMBUS, MISS.

SAME VIEW WITH ROUND-BOTTOMED DITCH NEARING COMPLETION

Benefits of Ohio Basin Reservoir System Exceed Carrying Charges

TO THE EDITOR: An error occurred in the printed summary of my paper on "Federal Plans for Flood Control" in the January 1937 issue. In the last sentence it is stated that "The direct annual benefits of this protection [the reservoir authorized by the Flood Control Act of 1936 for construction in the Ohio River basin] were estimated, prior to the 1936 flood, to be less than the annual carrying charges on the proposed system." This should have read: "The direct annual benefits of this protection were estimated, prior to the 1936 flood, to be in excess of the annual carrying charges on the proposed system."

W. E. R. COVELL, M. Am. Soc. C.E.
Lt. Col., Corps of Engineers
District Engineer, U. S. Engineer Office

Pittsburgh, Pa.
January 17, 1937

Unusual Type of Bridge Truss

TO THE EDITOR: The accompanying photograph of a bridge taken in New Mexico during the past summer may be of interest to your readers. Since I am not an authority on bridges, I would be interested in learning the proper name for this structure.

WHAT IS THE PROPER DESIGNATION FOR THIS TRUSS?

The span is an 18-in. steel pipe which conveys water across a "river." If my memory serves me, its length is about 40 ft. There are wires suspended from the A-frame to support the span, and there are also guy wires that hold the A-frame in place.

T. C. FORREST, JR., Assoc. M. Am. Soc. C.E.
Consulting Civil Engineer, Myers, Noyes, and Forrest

Dallas, Tex.
January 29, 1937

First Elevated Tank on Iron Tower

TO THE EDITOR: It has been suggested to me that it may be of interest to the readers of CIVIL ENGINEERING to learn of the construction of an elevated water tank, which was erected in 1888 during the period of my partnership with the late Charles F. Loweth, Past-President Am. Soc. C.E., under the title of Loweth and Curtis, operating from St. Paul, Minn. The general practice at that time was to pump water during the day to a standpipe, both to insure reasonable water pressure and to provide a supply of water during the night and during the hours when the pumps were not in operation—which in the smaller towns were many.

We were building water works that year for the town of Albert Lea, Minn., as I recall. The town is quite level, with no high ground nearby to give natural elevation to the bottom of the standpipe. It was rather distasteful to us to build a structure, containing water in one-half its space, which would be useless for its intended purpose. I was away at the time, and Mr. Loweth decided to build a stone tower, 80 ft high, on which he could locate a wooden, 100,000-gal tank—an ordinary railroad tank. The tower was well under way, in the drafting room, when I returned, and I at once objected that, while the stone tower was very effective from the artistic point of view, I was confident we could never build it for the amount we had available. However, we continued work on the design, advertised it, and found it beyond our pocketbook. We had both attended the letting and were quite puzzled as to how to meet the situation. After considerable discussion on the train returning home, we decided that if we could build towers of trestles to carry railroad trains, there was no good reason why some iron legs would not be a means of carrying the water. So we promptly carried out the idea, and the tower was designed, contracted for within our means, and successfully built. It was built with four posts of iron channels—steel was not available in those days—battered on four sides, with plate girders connecting the tops and one intermediate girder, and with wooden joists to carry the tank and floor above.

That became our regular construction thereafter, much to the distaste of the standpipe makers, who did all they could to persuade our clients of the superiority of the standpipe. I remember that one firm wrote me from New Jersey asking my price to supply them with plans for towers of varying sizes. As I did not think a plateworks was well qualified to make such a tower, I discouraged the idea.

The use of metal was not particularly original, but so far as we could learn then or since, it had never been done and was certainly a great convenience. We realized that the wooden tank was perishable, but we considered it good for perhaps twenty years, when we hoped the town would be in better financial condition and could replace the wood with iron. In fact, a year or two later, I designed a tower with a flat metal bottom and metal sides. I do not remember whether I built it or not.

W. W. CURTIS, M. Am. Soc. C.E.

Denver, Colo.
February 1, 1937

A Stadia Board Suitable for Use in the Tropics

DEAR SIR: The article on "Stadia Board for Long-Range Reading" by G. J. Swartz, Jun. Am. Soc. C.E., in the May 1936 issue of CIVIL ENGINEERING, recalls to my mind the type of board used by our survey parties in Nigeria, West Africa, about 1914. It was evolved by the late J. E. Selander, M. Am. Soc. C.E.

As seen in Fig. 1, the marking was simple. The unusual feature was the coloring. The face of the staff was painted yellow instead of white; the tenth markings were ultramarine blue, and the figures vermilion. The colors were found to assist materially in long-distance shots, and at 800 and 1,000 ft were comparatively clear even in the heat of the day.

The rods were of various lengths, up to 20 ft, the longer ones being of the two-section type. Each board was provided with a stiffening rib on the back, and a small folding circular bubble to assist the native survey boys in keeping the rod vertical. The average number of boards in use by a single observer per day was about 20, and in an emergency or in very rough country the number was sometimes increased to 30.

I trust that this information will be of some use to engineers in other tropical countries.

HARRY WEIGHTMAN, Assoc. M. Am. Soc. C.E.
Chief Civil Engineer, Sierra Leone Railway

Freetown, Sierra Leone
January 21, 1937

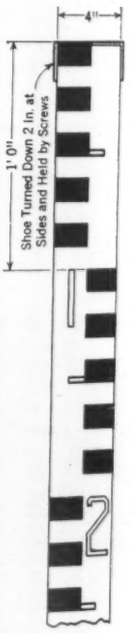


FIG. 1. STADIA BOARD USED IN NIGERIA

SOCIETY AFFAIRS

Official and Semi-Official

San Antonio in "Fiesta Week"

Delightful Program and Entertainment to Feature Society Spring Meeting, April 21–23

AFTER WAITING for eight years for another opportunity to entertain a Spring Meeting of the Society, members of the Texas Section are laying unusually elaborate plans for the various sessions and events which will comprise the gathering on April 21–23, 1937. The time itself has been arranged to coincide with "Fiesta Week," a unique celebration that is famed far and wide for its beauty, and for its festal Spanish flavor.

It was on April 21, 1836, that the Battle of San Jacinto was fought nearby, assuring the independence of Texas from Mexico. Today a monumental memorial of this historic event is under construction and will form the subject of one of the technical papers. Civil engineers who are fortunate enough to attend this Spring Meeting will have ample opportunity to enjoy this famous week of celebration with its Spanish "color." Texas engineers need no reminder, as the mention of Fiesta Week will immediately arouse their interest.

After the customary opening formalities on Wednesday, April 21, the remainder of the day will be devoted to a symposium presenting the variety and importance of the vast natural and developed resources of this great state of Texas. Engineers, industrialists, and scientists will present their various points of view, thus ensuring a well-rounded program covering a half dozen or more specialized phases of the general subject.

The following day, Thursday, is devoted in its entirety to sessions of five of the Society's Technical Divisions. The Construction and Structural Divisions are joining forces, but the Highway, Irrigation, and Surveying and Mapping Divisions have separate programs. A large number of papers are already in preparation. The Irrigation Division and also the Surveying and Mapping Division plan for double sessions, morning and afternoon. This rounds out the technical program. In addition, there will be a Local Section conference on Tuesday afternoon and a Student Chapter conference on Wednesday afternoon.

A complete list of social events and diversions is also in preparation. The ladies will have the opportunity to enjoy teas and drives. Then, on Thursday evening, they will be privileged to attend the "Coronation of the Queen," one of the most brilliant social features of the fiesta celebration. That same evening a typically southwestern "stag barbecue" is promised for the men. This particular part of the program is said to combine an excellent repast with a hilarious occasion that has become traditionally associated with various engineers' meetings in San Antonio.

Local excursions to nearby points of interest near San Antonio are planned for Friday, both morning and afternoon. Engineering, military, and aviation structures will be visited, also the historic Spanish missions. These trips, however, will be terminated in time for participation in the enjoyment of the "Battle of Flowers" parade, one of the beautiful and spectacular pageants crowning Fiesta Week.

Those who are familiar with the intense loyalty of Society members in Texas will realize that they have an unusual treat in store in the San Antonio meeting. Not only the many members in this Texas city of a quarter of a million population, but others throughout the state will consider it a personal responsibility to make the meeting a success. Always beautiful, San Antonio will appear at its best in the spring season. At this time visitors will be able to enjoy to the full its old Spanish atmosphere and beautiful natural surroundings, which make it one of the garden spots of the Southwest.

PLAZA AT MONTERREY, MEXICO—OBJECTIVE OF PROPOSED POST-MEETING TRIP

RANDOLPH FLYING FIELD, SAN ANTONIO, TEX.
The Administration Building Will Be a Point of Interest on Sight-Seeing Trips

The quaintness of old Spain may be further enjoyed on a post-meeting trip to Monterrey, Mexico, which has been planned for the benefit of all who attend. According to the advance arrangements, those taking this trip will leave on Friday evening and return to San Antonio on Sunday. Society members and Mexican friends are looking forward to this opportunity for sight-seeing and international hospitality which is expected to provide one of the most delightful and unique features of the Spring Meeting.

Meeting of Outgoing Board of Direction—Secretary's Abstract

January 17, 18, and 19, 1937

ON January 17, 18, and 19, 1937, the Board of Direction met at Society Headquarters, with President Daniel W. Mead in the chair; and present, George T. Seabury, Secretary; Past-Presidents Eddy and Tuttle; Vice-Presidents Riggs, Sawyer, Lupfer, and Dennis; Directors Ammann, Arneson, Barbour, Burdick, Crawford, Etcheverry, Ferebee, Finch, Hidinger, Hill, Leisen, McDonald, Morse, Myers, Poole, Proctor, Stabler, Trout, Wilkerson, and

Treasurer Hovey—that is, with every officer present. The members of the incoming Board were also present by invitation.

Approval of Report and Minutes

After studying the draft of the Annual Report, it was slightly revised in detail and approved. The minutes of the Executive Committee of December 14 were also approved, and its actions adopted as the actions of the Board, with the exception of two matters which were taken up individually. The minutes of the Board meeting held on October 11–12, 1936, were also approved.

Local Sections

Minor amendments to Local Section constitutions were approved as applying to the Philadelphia, Central Illinois, Puerto Rico, and Sacramento Sections. Request was presented in proper form for the establishment of a new Central Michigan Section and was approved.

Government Reorganization

Growing out of the suggestion from the Construction League of the United States, a Society representative was authorized to advise with respect to matters arising from the government study of the proposed federal reorganization, with power of action in any instance by specific authority of the Executive Committee.

Separately, the Board adopted a motion approving in principle the formation of a federal Department of Public Works, as proposed by the President of the United States.

Public Works Should Be Economically Sound

A resolution was adopted, advocating the return by the government to sound economic principles in the conduct of public works. This resolution is given in full elsewhere in this issue.

Provision for Reinstatement

Rules were adopted fixing the terms under which former members of the Society may be reinstated on favorable terms during 1937.

Professional Conduct

The cases of two members previously expelled from the Society were considered. After extensive investigation and study, the Board decided there was insufficient new evidence to warrant reopening these cases.

Student Chapters and Junior Members

Several matters were presented by the Committee on Student Chapters. Approval was given to the recommendation approving the formation of a Chapter at the University of Vermont, Burlington, Vt. Action was taken with recognition of special accomplishments of a number of Student Chapters as recommended by the committee. These are given in detail on another page of this issue. Two proposed constitutional amendments providing, respectively, for the formation of a grade of Student Member, and for changing the designation of "Junior" to "Junior Member," were considered.

Committee Reports

A number of committees of the Society and the Board submitted reports, most of which were received without special action. The recommendation of the Committee on Districts and Zones that there be no change for the year 1937 in District boundaries, number of Directors, and boundaries of the four Zones, was approved. A report with recommendations submitted by the Committee on Local Sections received consideration without final action. The Committee on Cement and the Committee on Dams were discharged with thanks. Statistical summaries were presented by the Committee on Public Education, the Committee on Publications, and the Committee on Membership Qualifications. At the suggestion of the Committee on Fees, it was voted to reprint the pamphlet, "Recommendations for Determining Fees to Be Allowed for Professional Engineering Services" as a separate publication. At the further suggestion of this committee, a study of the practices within the several federal departments, bureaus, etc., with respect to compensation for technical services is to be studied.

Honorary Membership

Consideration was given to a proposed Constitutional amendment whereby the number of Honorary Members elected in any one year may be increased from five to eight.

Flood Protection Data

Following the presentation of the Report of the Committee on Flood Protection Data, recommendations to the federal government were adopted, covering the continuation and extension of activities in various flood matters. Details are given in a separate item on another page.

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Death of John H. Gregory

Announcement of the death of John H. Gregory, M. Am. Soc. C.E., former member of the Board, was received with great regret. The following tribute was adopted for transmission to Professor Gregory's family:

"The Board of Direction of the American Society of Civil Engineers assembled in Annual Meeting in New York has learned with deep sorrow of the passing away of former Director John H. Gregory. Mr. Gregory was one of the outstanding men of our profession and his life work has contributed to the health of a large proportion of our population. He served on our Board of Direction with distinction during the years 1932, 1933, and 1934 and took an outstanding part in all movements designed to elevate the engineering profession and better the condition of engineers. The Board desires to express to Mrs. Gregory and her son Richard its sincere sympathy and to assure them that it shares in their grief."

Membership Application Procedure

As a detail of internal Board activity, a new method was adopted whereby consideration of membership applications will be simplified and the resultant labor of Board members lightened.

Budget

The proposed budget was presented, discussed in detail as to certain items and, as thus revised, was recommended for adoption by the incoming Board.

Encouraging Local Sections

As a policy it was voted to encourage the formation of new Local Sections where, and as seems desirable.

Appreciation of Vice-President Riggs

A citation was adopted, commending Vice-President Riggs for his work on the Board for five continuous years, during which time, in spite of serious handicaps, he has not failed to attend every Board session and in addition has handled several delicate assignments with great tact and understanding.

Matters of Routine

A number of matters of routine and record were also discussed and suitable action taken.

Meeting of Incoming Board of Direction—Secretary's Abstract

THE BOARD of Direction met at the Headquarters of the Society on January 21, 1937, with President L. C. Hill in the chair; and present George T. Seabury, Secretary; Past-President Mead; Vice-Presidents Lupfer, Dennis, Bellinger, and Gowdy; and Directors Arneson, Burdick, Crawford, Dean, Ferebee, Finch, Hill, Legaré, Leisen, Myers, Needles, Poole, Proctor, Shea, Stabler, Stanton, and Treasurer Hovey.

Diagramming or Tabulating Engineering Knowledge

As directed by the Society's Annual Meeting, the Board received the project submitted by J. A. L. Waddell, Hon. M. Am. Soc. C.E.,

looking towards the formulation by the Society of a symposium on "The Diagramming or Tabulating of Valuable Engineering Knowledge." Final decision was delayed pending additional study and information.

Fees for Consulting Services to the Government

Resolution was adopted asking American Engineering Council to secure full information as to laws, regulations, interpretations, and procedures affecting the engaging of civil engineers by the government for special services.

Budget Adopted

The budget as recommended by the outgoing Board for the year 1937 was received and adopted without change.

Committee Appointments

Suggestions for the personnel of Society committees were received from President Hill and approved by the Board, as follows:

EXECUTIVE COMMITTEE: L. C. Hill, *Chairman;* Arthur S. Tuttle, *Vice-Chairman;* Daniel W. Mead, E. P. Lupfer, and H. S. Morse.

COMMITTEE ON HONORARY MEMBERSHIP: L. C. Hill, *Chairman;* L. F. Bellinger, Harry W. Dennis, R. C. Gowdy, E. P. Lupfer, Daniel W. Mead, and Arthur S. Tuttle.

COMMITTEE ON DISTRICTS AND ZONES: T. A. Leisen, *Chairman;* C. A. Poole, E. P. Arneson, R. P. Davis, and Carlton S. Proctor.

COMMITTEE ON PROFESSIONAL CONDUCT: Harry W. Dennis, *Chairman;* L. F. Bellinger, Ivan C. Crawford, L. L. Hidinger, and R. P. Davis.

COMMITTEE ON PUBLICATIONS: C. B. Burdick, *Chairman;* James K. Finch, C. E. Myers, E. R. Needles, and Arthur W. Dean.

COMMITTEE ON MEMBERSHIP QUALIFICATIONS: Ivan C. Crawford, *Chairman;* Herman Stabler, E. P. Arneson, R. A. Hill, T. Keith Legaré, and William J. Shea.

COMMITTEE ON REGIONAL MEETINGS: *Annual Meeting:* E. P. Lupfer, *Chairman;* James K. Finch, E. R. Needles, Carlton S. Proctor, and William J. Shea.

Spring Meeting: Harry W. Dennis, *Chairman;* L. F. Bellinger, L. L. Hidinger, E. P. Arneson, and T. Keith Legaré.

Summer Convention: R. C. Gowdy, *Chairman;* James L. Ferebee, C. B. Burdick, Howard S. Morse, and T. A. Leisen.

Fall Meeting: E. P. Lupfer, *Chairman;* C. Arthur Poole, Herman Stabler, C. E. Myers, Arthur W. Dean, R. P. Davis.

COMMITTEE ON RESEARCH: Fred C. Scobey, *Chairman,* term ending January 1938; Albert F. Reichmann, term ending January 1939; Boris A. Bakhmeteff, term ending January 1940; C. H. Paul, term ending January 1941; and Charles B. Burdick, *Contact Member.*

COMMITTEE ON LOCAL SECTIONS: Andrew P. Rollins, *Chairman,* term ending January 1938; E. B. Black, term ending January 1939; A. T. Dusenbury, term ending January 1940; James W. Follin, term ending January 1941; and T. E. Stanton, Jr., *Contact Member.*

COMMITTEE ON JUNIORS: F. W. Green, *Chairman,* term ending January 1938; Howard R. Green, term ending January 1939; N. T. Veatch, Jr., term ending January 1940; Henry E. Riggs, term ending January 1941; and L. L. Hidinger, *Contact Member.*

COMMITTEE ON STUDENT CHAPTERS: H. W. Hanly, *Chairman,* term ending January 1938; E. M. Hastings, term ending January 1939; R. B. Wiley, term ending January 1940; A. H. Holt, term ending January 1941; and T. A. Leisen, *Contact Member.*

COMMITTEE ON ENGINEERING EDUCATION: Robert L. Sackett, *Chairman,* term ending January 1938; Joseph W. Barker, term ending January 1939; Leslie F. Van Hagan, term ending January 1940; Samuel B. Morris, term ending January 1941; and A. W. Dean, *Contact Member.*

COMMITTEE ON REGISTRATION OF ENGINEERS: C. E. Myers, *Chairman,* term ending January 1938; Joseph Jacobs, term ending January 1939; Ralph J. Reed, term ending January 1940; J. H. Dorroh, term ending January 1941; and T. Keith Legaré, *Contact Member.*

COMMITTEE ON FEES: E. R. Needles, *Chairman,* term ending January 1938; J. Vipond Davies, term ending January 1939; Frank A. Marston, term ending January 1940; Walter L. Huber, term ending January 1941; and Carlton S. Proctor, *Contact Member.*

COMMITTEE ON SALARIES: E. P. Goodrich, *Chairman;* A. B. McDaniel, *Vice-Chairman;* E. O. Griffenhagen, Arthur Richards, and Herman Stabler, *Contact Member.*

COMMITTEE ON PUBLIC EDUCATION: T. R. Kendall, *Chairman,* term ending January 1939; William H. Adams, term ending January 1940; Harry L. Kinsel, term ending January 1941; Howard S. Morse, *Director;* and James K. Finch, *Director.*

COMMITTEE ON TECHNICAL PROCEDURE: L. C. Hill, *Chairman;* R. C. Gowdy, *Board Member;* E. P. Lupfer, *Board Member;* Harold M. Lewis, Chairman City Planning Division; A. E. Horst, Chairman Construction Division; Edwin F. Wendt, Chairman Engineering-Economics and Finance Division; L. G. Holleran, Chairman Highway Division; Alfred Tamm, Chairman Irrigation Division; James W. Rickey, Chairman Power Division; Harry E. Miller, Chairman Sanitary Engineering Division; Carlton S. Proctor, Chairman Soil-Mechanics and Foundations Division; Eugene L. Macdonald, Chairman Structural Division; William Bowie, Chairman Surveying and Mapping Division; W. G. Atwood, Chairman Waterways Division; Fred C. Scobey, Chairman Committee on Research; C. B. Burdick, Chairman Committee on Publications; and George T. Seabury, *Secretary.*

COMMITTEE ON PROFESSIONAL ACTIVITIES: L. C. Hill, *Chairman;* A. W. Dean, T. E. Stanton, Jr., James K. Finch, L. L. Hidinger, T. Keith Legaré, T. A. Leisen, Howard S. Morse, Carlton S. Proctor, Herman Stabler, and George T. Seabury, *Secretary.*

COMMITTEE ON ACCREDITED SCHOOLS: Franklin Thomas, *Chairman,* term ending January 1938; John C. Riedel, term ending January 1939; W. C. Huntington, term ending January 1940; L. M. Gram, term ending January 1941; and E. R. Needles, *Contact Member.*

COMMITTEE ON AIMS AND ACTIVITIES: F. A. Barbour, *Chairman,* term ending January 1938; E. O. Sweetser, term ending January 1938; S. F. Voorhees, term ending January 1938; George G. Gascoigne, term ending January 1939; Howard S. Morse, term ending January 1939; T. E. Stanton, Jr., term ending January 1940; L. L. Hidinger, term ending 1940; and L. M. Lawson, term ending January 1940.

COMMITTEE ON SECURITIES: William H. Coverdale, *Chairman;* Chas. A. Mead, and W. C. Morris.

COMMITTEE ON FREEMAN FUND: Thaddeus Merriman, *Chairman;* Malcolm Pirnie, and Walter E. Spear.

COMMITTEE ON SOCIETY PROPERTY: Lincoln Bush, *Chairman;* George S. Davison, and Arthur S. Tuttle.

COMMITTEE ON ALFRED NOBLE PRIZE: Robert Ridgway, *Chairman.*

CONSTRUCTION LEAGUE OF THE UNITED STATES: L. C. Hill, Alonzo J. Hammond, John C. Hoyt, Carlton S. Proctor, and George T. Seabury.

Colorado Section Congratulates A. N. Talbot

A resolution was received from the Colorado Section, felicitating A. N. Talbot, Hon. M. Am. Soc. C.E., on his receipt of the John Fritz Medal.

Adjournment

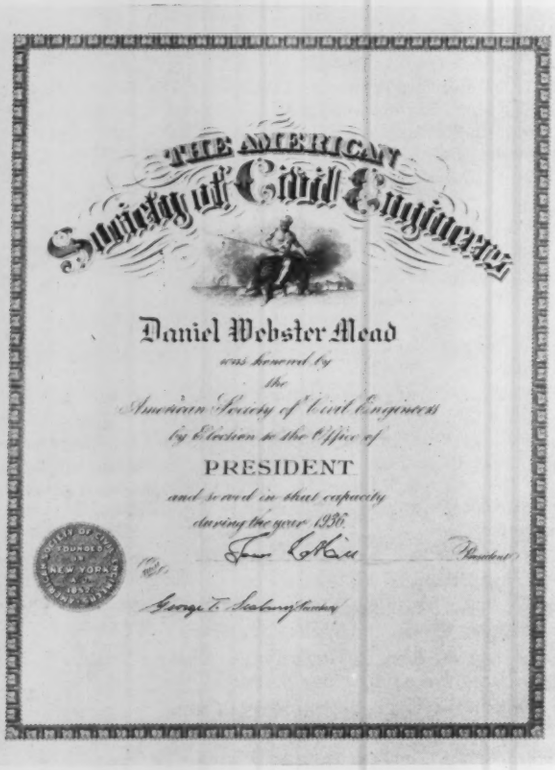
The Board adjourned to meet in connection with the Spring Meeting of the Society at San Antonio on April 19, 1937.

Certificates to Past Officers Attest Services

ALL THOSE who are, or have been, officers of the Society agree that although the demands upon time and energy are great, the pleasures incidental to the work and the satisfaction it gives are even greater. The privilege of service has been considered ample recompense, so that these officers have always found this a case where "virtue is its own reward."

Nevertheless, there have been indications from time to time through the years that some visible reminder of pleasant duties and associations would be highly prized by each Society officer as he retires from active service. The most popular suggestion was for a dignified form of certificate, suitable for display in an office.

This idea, in turn, was under continuous discussion for some months before the certificates for the 1935 group were issued, as noted and illustrated in the March 1936 CIVIL ENGINEERING. Discussion then ensued as to the need for improvement in the size, general appearance, and form of wording. The final decisions on these matters were made by the Executive Committee since its meeting in Pittsburgh in October 1936. A series of sketches was prepared embodying the features that were considered most desirable Adjustments were made at the suggestion of the staff and individual officers, and the adopted form, with a dignified border, was finally fixed. With the revisions completed, the new type of certificate was issued in January 1937, to those who were then completing their terms of service on the Board of Direction.



NEW SOCIETY CERTIFICATE AWARDED PAST-PRESIDENT MEAD

As a sample, the cut of the one bestowed on Dr. Daniel W. Mead, retiring President, is given herewith. This is the first one signed by the incoming President, Louis C. Hill. Its dimensions are $10^3/_4$ by $13^7/_8$ in., this size being selected as suitable for framing by itself, or for insertion at the lower right-hand corner of a previously framed certificate of membership.

These certificates were bestowed on all the retiring officers. In addition to Past-President Mead, recipients in January 1937 included Past-President Harrison P. Eddy, Vice-Presidents Henry E. Riggs and Donald H. Sawyer, and Directors O. H. Ammann, Frank A. Barbour, Bernard A. Etcheverry, Frederick H. McDonald, Charles E. Trout, and Thomas J. Wilkerson.

Society Meetings—1937

WITH THE SETTING of the official dates for the three quarterly meetings of the Society during the remainder of the year, it is possible to give official information for all members. The following details have now been determined:

Spring Meeting, San Antonio, Tex.—April 21–23, 1937
Annual Convention, Detroit, Mich.—July 21–23, 1937
Fall Meeting, Boston, Mass.—October 6–8, 1937

A more complete idea of the attractions in store for the San Antonio Meeting is given in another item in this issue. The Annual Convention, regularly held during the summer, returns to the Middle West after a number of years held on or near the Pacific coast. As this is the first Convention or other Society meeting in this general neighborhood since the famous Chicago Convention at the time of the Century of Progress exposition in 1933, it should command wide interest. Likewise, the Fall Meeting returns to New England and to Boston after an interval of eight years. The time for this meeting has been advanced somewhat ahead of the normal date, and it is believed it will bring visitors to New England when the autumn foliage is at its height and the tourist season in full swing.

Supplementing customary programs of entertainment and sociability, preparations are under way for excellent technical speakers and subjects. This information is supplied in advance so that all members may begin to lay plans for taking advantage of one of these Society meetings.

Conference on Vocational Guidance Held at Detroit

SELECTING ENGINEERING as a career was the theme of the vocational guidance conference held at Detroit, Mich., on December 11, 1936. The meeting was sponsored by the Engineering Society of Detroit, and was in conformity with the activities of the student selection and guidance committee of the Engineers' Council for Professional Development (E.C.P.D.), of which Dean R. L. Sackett is chairman. The purpose was not to "sell" engineering, but rather to present many facts concerning the profession to those coming graduates of high schools who contemplate studying it. Then it is left to the student, with such aid as he may receive from his parents and school counselors, to determine for himself if he wishes to proceed with his plans. The local committee has taken no definite steps towards selection of students, devoting its efforts only to their guidance.

The meeting was attended by more than six hundred people, of whom half were students from the high schools of Detroit and the metropolitan area, many coming from distant cities. S. M. Dean, chief assistant superintendent of the electrical system of the Detroit Edison Company, was the presiding officer, and Dr. William E. Wickenden, president of the Case School of Applied Science, delivered the main address on the subject "College and Career."

Immediately following the address, the students adjourned to various rooms where interviews were afforded with professional engineers as counselors. The counselors were selected by local sections of the American Chemical Society, American Institute of Architects, American Institute of Chemical Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society of Heating and Ventilating Engineers, American Society of Mechanical Engineers, American Society for Metals, Illuminating Engineering Society, Institute of Radio Engineers, and Society of Automotive Engineers. The success of the Detroit meeting is in a large part due to the excellent cooperation of the local sections. The outstanding engineers selected not only contributed their time to counselling but many have arranged trips for the boys through research laboratories and plants.

Dr. Wickenden emphasized that selecting an engineering career is a very critical matter. "Don't study engineering," he said, "unless you care enough about science to work hard in mastering the fundamentals of mathematics, physics, chemistry and mechanics. Don't study engineering if you are afraid to make decisions and take risks. Don't study engineering unless you are willing to live up to the austere code of mental integrity and honest dealing; there is no place in engineering for men who are merely 'smart,' 'smooth,' or 'clever'."

Further, Dr. Wickenden stated that in his opinion there will be plenty of jobs for the engineers of the future, and that the social ills which caused the depression can be overcome only by engineers and the government working hand in hand. Studies in college should come first, but he advised the students against neglecting athletics, debating, dramatics, music, journalism, and student government.

Each student was presented with a copy of "Engineering: A Career—A Culture." Two hundred and fifty copies of the Guidance Manual published by E.C.P.D. had previously been sent to the counselors and distributed to the high schools. A record card

was filled out by each student, and the committee, with the aid of the counselors, will endeavor to keep in touch with each of these students until after he has completed college and is placed on his first job.

Dr. F. O. Clements, technical director of the General Motors research laboratory, is chairman of the education committee of the Engineering Society of Detroit. The actual work of arranging the meeting was carried on by the subcommittee on student selection and guidance of E.C.P.D., with the following members: Dr. Warren K. Kayton, C. J. Freund, E. W. Spring, and A. R. Alliason, chairman. Local engineering societies in other sections of the country may have a copy of the program and further details by addressing the Engineering Society of Detroit, 272 Statler Hotel, Detroit, Mich.

Secretary Ickes Submits Mapping Program to Congress

A PROGRAM for expediting the topographic mapping of the United States was transmitted to the Senate on January 28, 1937, by Secretary of the Interior Harold L. Ickes, in accordance with the Senate Resolution of April 17, 1936. The suggested program "does not conform in detail to any one of the plans that have been prepared heretofore, but in general terms embodies ideas derived from them" and from the experience of the Department of the Interior.

It is encouraging to note this progress in the development of a project that the Society has persistently endorsed during the course of years. Extracts from Mr. Ickes' letter follow:

"The program heretofore prepared has attempted to foresee mapping conditions and needs that will exist 10 or 20 years hence and to provide for them by detailed estimates. It is not possible to forecast, except in general terms, the developments that will take place in such periods, nor with accuracy, the mapping needs of the country that will arise out of those developments.... A sound program should recognize these facts and should be flexible enough to permit of adaptation to changing conditions as they arise....

"The program submitted, therefore, is in broad terms, is for a limited period, and provides for less than the complete schedule of operations that will eventually be required to meet the needs of the nation. It ... presents a general estimate of the cost of a 20-year program but does not attempt detailed estimates for each year of such a program. If the present Congress is willing to accept and endorse the principle that the needs of this nation require far greater speed in map-making than has prevailed in the past, and will make provision beginning with the fiscal year 1936 for this accelerated progress, it is believed that it will have done all that it is practicable to do at present....

"The results of the work thus far done in continental United States exclusive of Alaska are indicated in the following table:

	Sq Miles
Adequately mapped (maps not more than 40 years old), 25 per cent	761,000
Inadequately mapped (maps more than 40 years old), 24 per cent.	741,000
Maps without contours; i. e., partly completed topographical maps, 5 per cent	165,000
Entirely unmapped, 46 per cent	1,359,000
TOTAL	3,026,000

"In contrast with the above situation in the United States, other major civilized countries of the world, such as France, Germany, Great Britain, and even India, are completely covered by contour maps....

"The more acute needs of the nation are not limited to the 46 per cent ... that is as yet totally unmapped, but include much of the area ... mapped more than 40 years ago and for which the maps are now badly out of date. They also require the addition of contours to a considerable part of the area ... that is now covered by maps without contours and more rapid progress in the mapping of Alaska and Puerto Rico.

"A reasonable program for present consideration should contemplate the mapping of about 1,500,000 sq miles.... Such a program may appropriately be considered for a period of 20 years, involving mapping of all types at an average rate of 75,000 to 85,000 sq miles annually. The cost of the mapping itself ... would be about $80,000,000 or $4,000,000 annually, and the cost of the triangulation and leveling would amount to about $20,000,000 more, thus constituting a $100,000,000 program involving total average annual expenditures of $5,000,000.

"Such a program would not complete the mapping of all the unmapped areas ... nor provide for all of the revision that will be required but ... under it the most acute needs can gradually be relieved. Moreover, such a program can be organized effectively during the first year of its operation, and be fully under way thereafter.

"Under a systematic program of this character, unit costs may confidently be expected to decrease ...; research can be undertaken that will contribute to speed and accuracy, particularly in the use of air photographs, and more rapid progress and a higher grade map product than is now obtained would be reasonably expectable....

"The program thus outlined should be entirely federal, but there should be no change in the provision made in section 2 of the Temple Act by which states and civic subdivisions that desire to expedite the work within their jurisdictions may contribute funds to these ends through the medium of cooperative agreements. Whatever contributions of this kind may be made would serve to expedite the general program and would be expended in the field."

The letter closes with the following specific recommendations:

"(1) The acceptance of the principle of a 20-year program, and the expenditure of $100,000,000 during that period as a general guide for legislative action.

"(2) An appropriation of $4,000,000 to the Geological Survey for 1938 ... for the purposes herein discussed.

"(3) An appropriation of $1,000,000 to the Coast and Geodetic Survey for 1938 for first and second order triangulation and leveling....

"(4) Elimination of the equivalent in the Department of the Interior appropriation bill for 1938 of the second proviso of paragraph 2, page 1786 of 49 Statutes as an undesirable restriction in the carrying out of the program herein outlined."

Engineers and others familiar with the needs of this country in terms of surveys and maps will second these suggestions for improving the present situation. Such a commendable outcome brings satisfaction to many Society members and officers, including Local Sections and the Surveying and Mapping Division, as reflecting the definite success of long-continued efforts. Securing the necessary congressional endorsement and appropriations would be directly in line with the recommendations advocated by the Society for many years.

Last Call for Discarded Cuts

THOSE DESIRING cuts from Volume V of CIVIL ENGINEERING—that is, 1935—should notify Society Headquarters before April 1, 1937, on which date all cuts from that volume not previously requested will be destroyed. Although requests first received will be filled first, preference will be given to the authors of the articles in which the illustrations appear. There will be no charge except the cost of forwarding by express or parcel post.

Cuts for the covers and pages of special interest in Volume V may be borrowed, but must be returned to Society Headquarters, where they will be kept on file.

Standards for Building Code Requirements

A NUMBER of standards for building code requirements are being developed under the general leadership of the American Standards Association. One study is being made of Building Code Requirements for Iron and Steel, and on this project the Society is acting as sponsor jointly with the American Institute of Steel Construction. The Society's representative in this study is H. G. Balcom, M. Am. Soc. C.E.

For another study, covering Building Code Requirements for Excavations and Foundations, the Society has accepted sole sponsorship. As its representative, Carlton S. Proctor, M. Am. Soc. C.E., has been appointed.

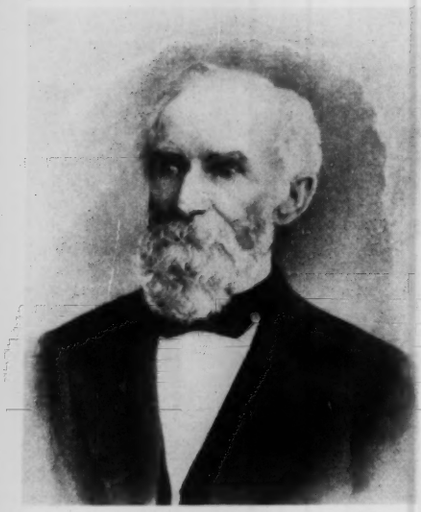
Early Presidents of the Society

This is the twelfth of the series of biographies of outstanding American engineers of the nineteenth century—all of them Past-Presidents of the Society. In the next three months the stories of Charles Paine, Don Juan Whittemore, and Frederic Graff will be told. Readers are invited to help in preparing these articles by contributing pertinent photographs, facts, and anecdotes.

XII. ASHBEL WELCH, 1809–1882

President of the Society, 1882

THE DELAWARE and Raritan Canal cuts across New Jersey about midway of the state, joining New Brunswick, on tidewater, with Trenton, on the western boundary. During the World War it was used to some extent to transport boilers for the emergency fleet, and other materials too large for railway carriage; but for the most part its use in the twentieth century has been confined to occasional pleasure boats. Today, as one strolls along the weed-grown tow-path at its side, it is difficult to realize that there was a time when the Delaware and Raritan was the most important connecting link between Philadelphia and New York, and that for years on end it far outstripped even the famous Erie Canal in tonnage.



ASHBEL WELCH
Twelfth President of the Society

Finished in 1834, the Delaware and Raritan did not begin to decline in importance until after the Civil War—long after most of the other artificial waterways had succumbed to railroad competition. Just to the south of it, the Camden and Amboy Railroad was operated, not as a competing enterprise, but as the high-speed unit of a coordinated system, handling passenger traffic and fast freight, while the canal carried coal, lumber, and other non-perishable commodities. For 39 years the engineering works of the two communication lines were in charge of Ashbel Welch, one of the few engineers of the nineteenth century who made valuable contributions to both forms of transportation.

Welch was born in New York State in 1809, seventh in descent from Governor Bradford of Plymouth. At the age of 18 he began his engineering career as a rodman on the Lehigh Canal (Pennsylvania), and worked on that project and on various railroads until 1830. That was the year in which the Delaware and Raritan Canal and the Camden and Amboy Railroad companies were chartered—separately, but almost immediately consolidated—and Welch "worked up from the bottom" in that organization.

In 1835 he was made chief engineer of the canal. Shortly afterward he made the reconnaissance for, and later built, the Belvidere Delaware Railroad, which followed the banks of the Delaware from Trenton to near the Delaware Water Gap. This line became a part of the Pennsylvania system in 1878.

Among the promoters of the Delaware and Raritan Canal was Commander R. F. Stockton—later famous for his action in the Mexican War—who had invested most of his private fortune in the enterprise. Stockton was an earnest advocate of steam vessels for the Navy, and enlisted Welch as his assistant and consulting engineer in preparing plans for the first ship-of-war of that type. About that time there came to the United States the Swedish engineer John Ericsson, inventor of the screw propeller, who had failed to interest the British Admiralty in his device. He met with better success in this country, and the ultimate result of the collaboration of these three men was the *Princeton*, launched in 1844, the first steamship ever built with the propelling machinery under the water-line and out of reach of shot, and the pioneer of the United States' steam-powered fleet.

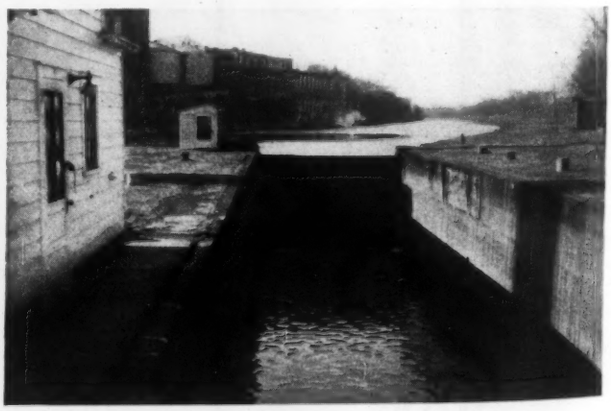
Welch later made two other contributions in the line of military engineering. In 1844 he visited Europe to supervise the construction of a large wrought-iron gun for the Navy, and in 1861 he made extensive investigations in connection with the construction and alteration of the great Stevens floating battery at Hoboken. (Stevens was another financier with heavy interests in the eastern canals and railroads, and was the founder of Stevens's Institute of Technology.)

In 1847 the foundation of the lock at Bordentown, the western terminus of the Delaware and Raritan Canal, failed. It had been built on a very fluid quicksand, and the settlement of the walls was so serious that it was necessary to replace the structure completely. Welch took an entirely new departure in the reconstruction, and discarding piling, cribbing, masonry, and so forth, decided to build the lock on the quicksand itself. He constructed the entire structure of timber, on land and at some distance from the site. The sides were divided in cells and all parts were carefully jointed and thoroughly caulked. Then the structure was launched, floated into the pit that had been dredged for it, and sunk by filling the cells with gravel. The inlet and outlet were carefully protected by lines of heavy steel piling, perfectly watertight. The work was successful; 35 years later it was stated that not the slightest settlement had occurred.

Welch was an administrator as well as a technician. He demonstrated this ability in 1853, when the stockholders of the Delaware and Raritan suddenly decided that the canal was to be enlarged, and that the work was to be completed in three months. There were 12 locks to be lengthened, two of them tidewater locks requiring heavy cofferdams, and there was one new lock to be built. The work was scattered across the state; there was no organization set up for the work; labor was scarce; and it was in the dead of winter when the order was given. Eighty-six working days, and it took 35 of them to make the preliminary arrangements! But the work was completed on schedule.

In the fall of the same year, Welch was retained to prepare the plans, make the contracts, and supervise the work on the Chesapeake and Delaware Canal, the intracoastal shortcut from Philadelphia to Baltimore. During the course of this engagement his health broke down, and he went to Europe to recuperate, but returned to complete the work. The canal was opened in May 1855.

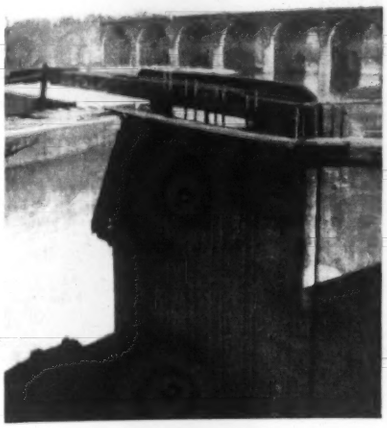
In 1862 Welch became vice-president and executive officer of the Camden and Amboy Railroad, and became active in arranging the consolidation of various transportation lines in New Jersey. In 1867 the arrangements were completed, and he was elected president of the consolidated companies, which operated one canal and two lines of railway between New York and Philadelphia. These properties were leased to the Pennsylvania Railroad in 1871, and



SOME 2,000,000 TONS OF PHILADELPHIA–NEW YORK FREIGHT PASSED ANNUALLY THROUGH THIS LOCK IN THE 1860'S
The Delaware and Raritan Canal, at New Brunswick, N.J.

the railroads are a part of its main system today, though the canal has fallen into disuse.

The earliest installation of the block signaling system that later came into use on American railroads was made on the Camden and Amboy, between Philadelphia and New Brunswick, in 1863. The innovation was the work of Welch. By 1858 the block system had been established in England, but its operation was essentially negative in character; that is, trains could enter a block freely unless a danger signal was displayed. Welch's scheme provided positive protection. Under it, a definite safety signal was required before a train could proceed, and of course the signal could not be given until the preceding train had cleared the block.



DOWNSTREAM VIEW OF THE LOCK AT NEW BRUNSWICK

The Gates Are Operated by Man-Power, Applied at the Outer Ends of the Horizontal Beams

Welch made other valuable contributions to railroad engineering. He invented an improved car truck (1869), made comprehensive studies of the proper form and dimensions of rails, and secured the manufacture (1866) of steel rails of a pattern substantially similar to that later considered standard. He also made important suggestions on the manufacture of car wheels.

Meanwhile, he retained his interest in water transportation. In 1868 the Delaware and Raritan Canal reached the limit of its carrying capacity (somewhat over 2,850,000 tons per year), and he promptly increased it by some 50 per cent by devising a method of applying steam power to operate the locks and haul the vessels in and out of them. In later years, when the proposals for an Interoceanic Canal at Panama or Tehuantepec became the subject of violent debate, his discussions in favor of such a project added largely to the interest and carried considerable weight.

Welch is described by the writer of his memoir as being of a most equable temper, thoroughly self poised and disposed to make the largest allowance for faults of temper in others. He was deeply religious, and never permitted his other duties to interfere with active church and charitable work. He was for many years an elder of the Presbyterian church.

His conception of his profession is perhaps best exemplified in the remarks he made at the Society's Convention in Montreal, in June 1881. The civil engineer, he said, "has made the bonds that unite the North and South of the United States .... I believe that the railroads ... have done more than any other cause, except religion, to harmonize those sections of our common country. And so it is with other countries. Canada and the United States are now practically one people, though under different governments. That engineer has a very inadequate conception of his mission who considers that material good, commercial good, is the highest end of his profession. The real and highest result accomplished by the engineer is by the works he constructs, the railways, the telegraphs, and the steamships by which he unites the distant regions of the whole world, to assimilate, to civilize, and to Christianize the human race."

Welch died while holding the office of President of the Society, September 25, 1882.

Economics of Public Works

After a discussion of engineering developments in connection with public works, the Board of Direction at meeting on January 19, 1937, adopted the following resolution:

"WHEREAS the federal government has believed it desirable during the emergency created by the recent depression, for the purpose of relieving unemployment and stimulating recovery, to undertake many public works of a technical engineering nature but of doubtful economic value, and

"WHEREAS, the emergency appears to be rapidly passing, and

"WHEREAS, a continuation of the above policy cannot but result in weakening the standards and principles of sound engineering practice,

"*Therefore be it resolved*

"That the Board of Direction of the American Society of Civil Engineers hereby strongly endorses the return by the federal government, at the earliest possible moment, to the application of sound economic principles in the study and the approval of all public works, and

"Furthermore,

"That this Board believes it is essential for the information of the public, and for the protection of engineering standards, if further social or relief works be undertaken, that the distinction be drawn as clearly as possible between such works and those public works undertaken as economically sound."

Value of Flood Protection Data

UPON PRESENTATION of the annual report of the Society's Committee on Flood Protection Data, the Board at its session on January 18, 1937, thought it desirable to approve and support several specific recommendations of the committee. It therefore adopted the following recommendations:

"That the federal government:

"(*a*) Continue the collection and publication of flood data in tabulated form, the same to include all records of importance which have not yet been published in public document form;

"(*b*) Make an inventory of the great historic floods of early days;

"(*c*) Make a study of cloudburst floods, their causes and frequency of occurrence;

"(*d*) Publish flood data in the future in pamphlet rather than in book form, the contents of each pamphlet to be restricted to one river basin or geographical group of streams for the purpose of facilitating distribution as well as republication in order that records may be kept up to date;

"(*e*) Initiate a campaign of education aimed at checking the ever-growing annual toll of damage by floods, by pointing out the dangers of locating valuable property in flood zones, thus putting available flood records to practical use for the common good."

It is expected that fuller details of this report will be published ni an early issue of PROCEEDINGS.

Regional Conferences of Student Chapters, Spring 1937

THIS IS the season when groups of Student Chapters, organized by regions, get together for their annual sessions. Society Headquarters has definite information of six such meetings between the end of March and early May 1937.

In point of time, the earliest conference is that of the Virginia Chapters, which will meet at the University of Virginia, Charlottesville, on Saturday, March 27. This is the third annual meeting of this group and will be crowded with student papers, talks by a few practicing engineers, an interesting inspection trip, and a tea dance. Lloyd T. Olsen, secretary of the University of Virginia Student Chapter, can supply detailed information.

On April 2 and 3 the Chapters in the South Atlantic and Gulf area will gather at Auburn, Ala., as guests of the Alabama Polytechnic Institute Chapter. This is the second annual meeting of this group. This conference will have two particular distinctions. First, it is being held at the same time and place as the regional conference of the Student Chapters of the American Institute of Electrical Engineers. Second, on Saturday, April 3, both conferences will participate in the events of Engineers Day, in which all the engineering groups on the campus of Alabama Polytechnic Institute will stage their annual demonstration. D. Sig. Pruitt, Sigma Chi House, Auburn, is secretary of the Student Chapter

that will play host. All the Chapters in the southern area have been invited to participate.

Notice was given in the February issue that the Maryland–District of Columbia regional conference will meet at Johns Hopkins University on Monday, April 19, for its all-day conference. The Chapters enrolled in this regional group are near enough to each other to permit preliminary meetings of an executive committee composed of two representatives from each of the four Chapters, which greatly facilitates the advance arrangements. A varied program is being prepared and all Chapters that can find it possible are invited to send representatives to Baltimore on that date. This also is a second annual meeting.

On the same date, Monday, April 19, the ten Chapters in the Philadelphia region will convene at Villanova College, Villanova, Pa., for an all-day session. As in past years, the principal feature of this conference will be the presentation of student papers for prizes. The Philadelphia Section is contributing the first prize, consisting of $20 plus a Junior membership in the Society, and a second prize consisting of a Junior membership in the Society. The Lehigh Valley Section is contributing a third prize consisting of still another Junior membership. The papers will be presented morning and afternoon, with lunch furnished by Villanova College. The officers of the Student Chapter of the host institution are ex-officio officers of the convention. M. Joseph O'Brien is secretary of the Villanova Chapter.

On Saturday, April 24, the Chapters in the metropolitan area, eight in number, will hold their fourth annual spring conference for the presentation of student papers and the award of prizes. As in the Philadelphia group, prize winners are determined by vote of the audience. It has not yet been decided which Chapter or Chapters will entertain the conference, but that detail can be learned by correspondence with Secretary Harvey W. Sarven, 58 Linwood Place, East Orange, N.J. In addition to the presentation of student papers, there will be a luncheon for the whole group and an entertainment in the late afternoon, also an opportunity to inspect laboratories.

The Rensselaer Student Chapter has taken the initiative in assembling Chapters in or near upstate New York for a conference on Friday and Saturday, May 7 and 8. The first conference of this series was held a year ago at Cornell. The administration of the Rensselaer Polytechnic Institute has made arrangements to put up the student representatives for the night. Registration will begin at 7 p.m. on Friday and will be followed by an entertainment. The Saturday session will begin promptly at 8 o'clock and will include the organization of the group into a permanent regional conference. There will also be an inspection trip through the plant of W. and L. E. Gurley, manufacturers of surveying instruments; a group luncheon; an afternoon session, with the reading of student papers for prizes; and finally, an open forum on prearranged topics. Robert K. Palmer, vice-president of the Rensselaer Student Chapter, 239 North Elm Street, Schenectady, N.Y., is in charge of arrangements. All Chapters in the northeastern region are cordially invited.

Promoting Plans for the Merit System in Government Agencies

IN THE LIGHT of the recent announcement by President Roosevelt of a plan for placing the entire government administrative service on a career and merit basis by making civil service include all non-policy-determining positions under the chief executive, it is of interest to note the active rôle which the Society and engineers in general have played and are still playing in support of this general purpose. In discussing the improvement of civil service, it has been the consistent viewpoint of Society officers that universal adoption of the merit system is needed, not only throughout the government service but in even greater degree throughout state and local government agencies, and that its establishment would do much to improve the economic status of engineers.

After special study, the Society's Committee on Aims and Activities has quite recently recommended full acceptance of the principle involved. For many years the Board of Direction has interested itself in the problem; its records for 1931, 1932, and 1935 (two meetings) indicate its activities, emphasizing that it "approves the principles underlying the merit system and endorses the correction of abuses" as a program to be furthered.

In line with these expressed policies, the Field Secretary has made extensive studies of the various questions involved. In every city he has visited, he has made inquiries as to the status of civil service as it affected engineers in that locality, at the same time urging all members of Local Sections that they keep close watch of its practical operation. It has been further pointed out that they should endeavor to perfect the working of the civil service and to use every effort to effect the introduction of the merit system where it does not already exist.

American Engineering Council, representing this and other societies, has been active in the current movement and is using its contacts with congressional committees, the Civil Service Commission, and the Civil Service Reform League to help substitute ability and experience for patronage. Engineers everywhere will approve this campaign to give greater security to professional men in public service by demanding efficiency in government administration and the selection of employees according to individual fitness.

Committee on Fees Finds A.I.A. Accounting System Adaptable to Use of Engineers

IN 1935 the American Institute of Architects published a *Manual of Accounting* for the use of its members in private practice. This manual contains a compact and lucid exposition of the principles of bookkeeping and accounting, and reproductions of 38 forms designed especially to meet the needs of an architect's office.

This work has been reviewed by the Society's Committee on Fees, to determine whether a similar system might be designed for the use of engineers. The committee reports that such a project appears to be unnecessary. It considers the Institute's system excellent, approves its forms, and states that with only minor revisions they should be applicable to engineers in private practice.

This manual and its supplementary forms are on file in the Engineering Societies Library, where they may be consulted. Individual copies, if desired, should be secured from the American Institute of Architects, 1741 New York Avenue, N. W., Washington, D.C. The price is $5.00 a copy.

Credit to Student Chapters

RECOGNIZING the active efforts of various Student Chapters of the Society in enlarging the services to their membership and the Society during the past year, the Board at its meeting on January 18, 1937, considered means of giving official recognition. In so doing, it followed the suggestions of the Committee on Student Chapters. One form of acknowledgment singled out three Chapters for conspicuous progress during the year 1935–1936. Accordingly, special letters of commendation were authorized to these Chapters for their outstanding work. They are:

Clemson Agricultural and Mechanical College of South Carolina, Clemson College, S.C.
George Washington University, Washington, D.C.
University of Alabama, University, Ala.

Another group was especially designated because of meritorious work during the year, as disclosed by their annual reports. The following Chapters were those to which such letters of commendation were to be sent officially:

Carnegie Institute of Technology, Pittsburgh, Pa.
University of Delaware, Newark, Del.
Duke University, Durham, N.C.
University of Illinois, Urbana, Ill.
Iowa State College, Ames, Iowa
Kansas State College, Manhattan, Kans.
Montana State College, Bozeman, Mont.
University of New Mexico, Albuquerque, N.Mex.
College of the City of New York, New York, N.Y.
Newark College of Engineering, Newark, N.J.
Tulane University, New Orleans, La.
Virginia Military Institute, Lexington, Va.

These actions by the Board were designed to give some measure of recognition for preeminent success. It was recognized that their real benefits accrue to the Chapters individually and entirely apart from any special identification.

Memoirs of Deceased Available

WITH THE PRINTING of Vol. 101 of TRANSACTIONS, a long list of memoirs, previously available only in preprint form, have been added to the Society's permanent archives. The following memoirs will not appear in the TRANSACTIONS until Vol. 102 is published, next fall:

William Anderson Aycrigg	1859–1936
Edward Gatling Bradbury	1870–1936
Arthur Taylor Bragonier	1890–1936
Thane Ross Brown	1870–1934
John Brunner	1864–1936
Frederick Hosmer Cooke	1879–1936
William Driscoll	1870–1935
Robert Fletcher	1847–1936
Christopher Lawrence Gates	1848–1920
Martin Gay	1854–1935
George Tillinghast Hammond	1863–1936
John Quentin Jamieson	1855–1932
Giles Matthew Jowers	1869–1936
William Datus Kelley	1859–1936
George Bertram de Betham Kershaw	1874–1935
August Gustave Kleinbeck	1852–1936
Robert Whitman Lesley	1853–1935
Clifford Sherron MacCalla	1876–1936
Robert Wentworth Macintyre	1867–1936
James William Norton	1889–1936
Walter Camp Parmley	1862–1934
Hugh Pattison	1872–1936
Andrew Jackson Post, 2d	1871–1936
Douglas William Ross	1865–1935
Clarence Horace Schwartz	1893–1936
Zenas Harrison Sikes	1874–1936
Frank Ormond Whitney	1851–1936
Hans Hermann Wolff	1877–1935

A Popular Society Paper

IN OCTOBER 1925, the Society was privileged to print a paper entitled "Moments in Restrained and Continuous Beams by the Method of Conjugate Points," under the authorship of L. H. Nishkian and D. B. Steinman, Members Am. Soc. C.E. The subject proved very interesting and popular, so that discussion extended over many months and the entire paper and discussion, aggregating over 200 pages, was eventually printed in Volume 90 of TRANSACTIONS (1927).

In accordance with regular practice, reprints were provided for independent sale. Although a special demand was anticipated and a generous quantity was therefore provided, it proved insufficient for the need. This first supply was exhausted in 1929.

To meet the continuing need, an additional set of reprints was prepared in 1932, but this too has subsequently been exhausted (1936) without filling all the orders. So it has become necessary to make a second reprinting of the paper, which is now made available. Standing orders will be filled and new requests can also be honored.

This third printing of the papers by Messrs. Nishkian and Steinman is an indication of its practical value to engineers. Some of those who find it more convenient to use a pamphlet copy than to refer to the 1927 TRANSACTIONS may wish to avail themselves of the present supply, which is available at the regular price of $2.00 per copy, on which a discount of 50 per cent is allowed to members.

Supplementing Stock of "Transactions," Volume 101

THE CURRENT volume of TRANSACTIONS, Volume 101, published last fall, had been in active preparation since the summer of 1936. At that time the various papers were gathered together with all their discussions and closure. Errors were rectified and other corrections made as required. Printing proceeded during the summer for publication in the fall.

Prior to all this, the proposed edition had to be set and the necessary materials, largely paper, had to be ordered in advance. What seemed like a generous provision was made at that time for future demands for this volume. In particular it is always difficult to forecast, almost a year ahead, just how large will be the paying membership, that is, those who are eligible to receive TRANSACTIONS when it becomes available.

As it happened, succeeding experience indicated a considerably greater need than was anticipated. As a result, the edition has fallen short of requirements by several hundred copies. Meanwhile, orders have been piling up and disappointments experienced because of the inability of the Society to provide the required volumes.

Studies at Headquarters have indicated that the solution is not a simple one. In particular, complications arise because the type material is destroyed as soon as the various sections or "forms" are run off by the printer. Recourse, therefore, had to be had to the process of photolithography, whereby it was possible to supplement some of those sections for which the stock of printed sheets was particularly low.

Plans are now under way for replenishing the stock of Volume 101 of TRANSACTIONS. According to promises by lithographers and binders, an ample supply will be ready some time during March, so that all pending orders can be satisfied.

Difficulties such as these have some compensation, however, particularly in emphasizing the wide interest in Society publications. Letters from members and others, particularly from engineers in foreign lands, have emphasized the value of TRANSACTIONS and the esteem in which these volumes are held.

Appointments of Society Representatives

H. G. BALCOM, M. Am. Soc. C.E., has been appointed Society representative on the Building Code Requirements for Iron and Steel of the American Standards Association.

WILLIAM BOWIE, M. Am. Soc. C.E., will represent the Society on the Advisory Council of the U. S. Board of Surveys and Maps, regarding the coordination of federal map-making.

CHARLES B. BURDICK, M. Am. Soc. C.E., was appointed to represent the Society on the occasion of the presentation of the Washington Award to Frederick Garden Cottrell, which took place at a dinner at the Hotel Drake in Chicago on February 23.

CHARLES B. HAWLEY, M. Am. Soc. C.E., has been appointed to advise with the Construction League of the United States relative to federal reorganization.

DANIEL W. MEAD, President Am. Soc. C.E., represented the Society at the seventeenth annual convention of the National Council of State Boards of Engineering Examiners, held in Knoxville, Tenn., October 19–21, 1936.

RUDOLPH P. MILLER, M. Am. Soc. C.E., has been appointed the Society's alternate representative on the Standards Council of the American Standards Association.

CARLTON S. PROCTOR, M. Am. Soc. C.E., will represent the Society on Building Code Requirements for Excavations and Foundations of the American Standards Association.

CARLTON S. PROCTOR, M. Am. Soc. C.E., will serve as Society representative on the project known as "Building Code Requirements for Excavations and Foundations," which is a part of the Building Code Project of the American Standards Association.

ROBERT RIDGWAY, Past-President and Hon. M. Am. Soc. C.E., served as the Society's representative at the ceremonies held by the American Society of Mechanical Engineers, at the time of its annual meeting, in celebration of the ninetieth birthday of Dr. Ambrose Swasey, Hon. M. Am. Soc. C.E., in December.

EDWARD W. ROEMER, Assoc. M. Am. Soc. C.E., has been appointed to represent the Society on the Central Committee on Lumber Standards (Simplified Practice Recommendation R-16–29) of the National Bureau of Standards of the U. S. Department of Commerce.

Preview of Proceedings

By HAROLD T. LARSEN, *Editor*

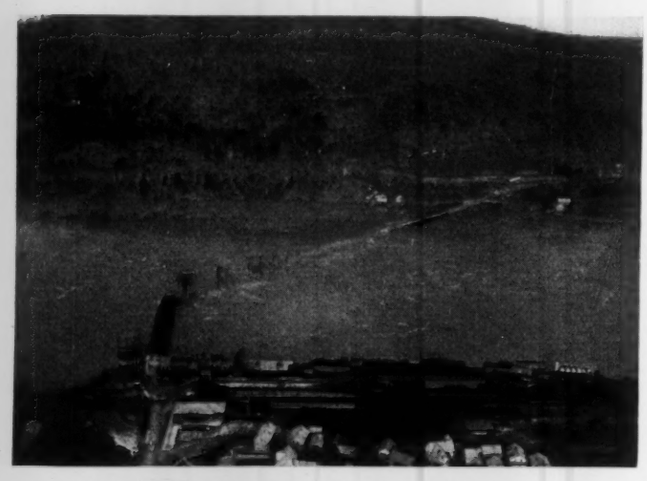
Floods and flood protection hold the center of the stage, so to speak, in the March number of "Proceedings." In this issue a generous amount of space will also be allotted to discussions of papers published in recent months.

SYMPOSIUM ON NATIONAL ASPECTS OF FLOOD CONTROL

At the Fall Meeting of the Society, held in Pittsburgh in October 1936, one of the liveliest topics of discussion was flood control. Within the year, record-breaking stages throughout the East had caused direct damages amounting to well over a quarter of a billion dollars and an undetermined amount of indirect loss that affected the entire nation. Later, Congress had passed the Omnibus Flood Control Act, setting up a basis for government participation in protection works, and authorizing construction of a long list of projects.

As the March issue of PROCEEDINGS goes to press, the 1936 flood losses have already been surpassed along a thousand miles of river in the Ohio and Mississippi basins. Within the next few months there will be feverish efforts to get protective works under way. It is a good time to take stock of some of these projects, to review the economic and social value of flood control in general, and to analyze the provisions of the Flood Control Act of 1936.

All these matters are discussed in the eight papers comprising the symposium on National Aspects of Flood Control. These papers were first presented at the Pittsburgh meeting, and as short summaries were published in the January 1937 issue of CIVIL ENGINEERING, it is only necessary here to refer briefly to their content. In "Federal Responsibility for Flood Control," Senator James J. Davis outlines the legal arguments for federal participation. Lt. Col. W. E. R. Covell, reviewing the history of federal flood control activity, presents the salient features of the 1936 act, and sketches the proposed plans for Ohio River regulation. Abel



Official Photograph, Eighth Photo Section, Air Corps, U. S. Army

BRIDGE AT BRATTLEBORO, VT., DURING MARCH 1936 FLOOD

Wolman, M. Am. Soc. C.E., discusses the problems of engineering, finance, and administration involved in developing a national flood protection policy, and stresses the importance of a gradual approach, attention to other uses of water, and flexibility in whatever program may ultimately be adopted. Economic and social aspects of flood control are presented by Nathan B. Jacobs, M. Am. Soc. C.E., who stresses the indirect losses that often cannot be evaluated in dollars. The following three papers of the symposium analyze, respectively, flood conditions in New England, the New York floods of 1935 and 1936, and the 1936 flood in the upper Ohio basin. The authors are, respectively, W. F. Uhl, Arthur W. Harrington, and Hollister Johnson, and E. K. Morse

Official Photograph, Eighth Photo Section, Air Corps, U. S. Army

AN AIR VIEW OF HARTFORD, CONN., IN MARCH 1936
The Capitol Is in the Foreground

and H. A. Thomas, all members of the Society. The symposium concludes with a paper by the late Montrose W. Hayes, chief of the River and Flood Division of the U. S. Weather Bureau, who outlines an ideal organization for the flood-forecasting service.

Credit for much of the work in assembling these papers should go to the committee that arranged the general sessions at the Pittsburgh Meeting. Its members were E. K. Morse, chairman; N. B. Jacobs, J. P. Leaf, George M. Lehman, C. M. Neeld, N. Schein, and H. A. Thomas.

FLOOD PROTECTION DATA

The report of the Committee of the Society on Flood Protection Data, presented as of the first of this year, contains some vitally interesting conclusions, especially as applied to events that have occurred since it was written. This short description of the problems involved in handling floods, with the discussion it is expected to inspire, should prove important in the creation of a fund of knowledge with which to solve a truly colossal problem.

News of Local Sections

ALABAMA SECTION

The Alabama Section was host to the Birmingham Engineers' Club at an open meeting held at the Thomas Jefferson Hotel in Birmingham on January 15. The speakers for the occasion were A. C. Polk and R. A. Polglaze, respectively chairman and secretary of the State Board of Registration for Professional Engineers and Land Surveyors. A general discussion of various aspects of the registration law followed. During the business session the following officers were elected for 1937: Joseph W. Cotlin, president; Joseph B. Converse, vice-president; and Wilfred G. McConnel, secretary-treasurer.

CENTRAL OHIO SECTION

There were 23 present at the regular monthly luncheon meeting of the Central Ohio Section, which was held at the Chittenden Hotel in Columbus on January 14. On this occasion the guest speaker was Frank E. Seehan, city manager of Portsmouth, Ohio, whose topic was "Engineering Problems of a City Manager." During this talk Mr. Seehan sketched the history of the famous Portsmouth flood-protection works and outlined the program now under way to improve these works.

CLEVELAND SECTION

On February 2 the Cleveland Section held a luncheon meeting in the Cleveland Chamber of Commerce Rooms. Brief résumés of

the Annual Meeting of the Society, recently held in New York, were given by C. H. Splitstone and Prof. G. E. Barnes. The meeting was well attended by members of the Section, ten or more having made the trip to New York for the occasion. A talk on river, harbor, and lake-front improvement was then given by George B. Sowers, chairman of the Cleveland Port and Harbor Commission. Mr. Sowers summarized the need for improved and condensed docking facilities and enlargement of recreation and transportation facilities, emphasizing the necessity of cooperation between industry, property owners, and the government.

COLORADO SECTION

There were 32 present at a business meeting of the Colorado Section, held at the Olin Hotel in Denver on January 11, and 25 at the dinner preceding it. During this session various announcements were made and committees were appointed. R. E. Van Liew, junior correspondent for CIVIL ENGINEERING, reported on his own activities and the activities of the Colorado Junior Association during the past year, and H. J. Tebow read the constitution presented by the Association to the Section for adoption.

DAYTON SECTION

Members of the Dayton Traffic Commission and of the University of Dayton Student Chapter were among the 29 present at the regular scheduled meeting of the Dayton Section, which took place at the Engineers' Club on January 18. A talk on the "Dayton Traffic Survey of 1936" was given by B. T. Schad, head of the civil engineering department at the University of Dayton and also president of the Section. Professor Schad discussed the methods being employed in the solution of traffic problems throughout the country and stressed the fact that traffic work must be handled by engineers who are specialists in the field. The Section then went on record as being willing to cooperate with the traffic commission in the solution of its problems.

DETROIT SECTION

An illustrated paper on the design and construction of the Mortimer E. Cooley Bridge across the Pine River between Manistee and Cadillac comprised the technical program presented at a meeting of the Detroit Section held at the Hotel Statler on January 8. This paper was presented by Lester W. Millard, bridge engineer of the Michigan State Highway Department. [A photograph of the bridge appeared on page 782 of the November 1936 issue of CIVIL ENGINEERING.] In the discussion that followed James H. Cissel, professor of structural engineering at the University of Michigan and engineer of bridge design for the State Highway Department, gave many interesting side-lights on the project. At the conclusion of this program a social hour was enjoyed. There were 58 present.

DISTRICT OF COLUMBIA SECTION

The District of Columbia Section, together with the American Engineering Council and nineteen other engineering organizations, sponsored the Annual All Engineers' Dinner on January 15. About 425 members and guests were present. After a convivial reception and dinner an excellent group of speakers was heard, including Rear Admiral Harold G. Bowen, Dr. Charles F. Hirshfeld, and Senator Joseph C. O'Mahoney. Donald H. Sawyer, retiring Vice-President of the Society, acted as toastmaster. At the annual dinner meeting of the Section, which took place at the Washington Hotel on January 25, the following officers were elected for the ensuing year: Carl G. Paulsen, president; George B. Pillsbury, vice-president; and Clifford A. Betts, secretary-treasurer. Short talks were given by President Louis C. Hill, Vice-President L. F. Bellinger, and Director Herman Stabler. The other speakers were Anis Azer, first secretary of the Egyptian Legation, who discussed the Nile and irrigation systems in Egypt, and John P. Frey, president of the metal trades department of the American Federation of Labor, whose topic was "Trade Unionism and Federation." There were 111 present.

ILLINOIS SECTION

At a luncheon meeting, held on January 29, about 45 members of the Illinois Section heard a symposium on flood conditions along the Ohio, White, and Mississippi rivers. Among the speakers on this program were L. W. Hall, hydraulic engineer for the Sanitary District of Chicago; W. G. Arn, assistant engineer for the Illinois Central Railroad; L. R. Howson, consulting engineer of Chicago; and Paul Hansen, of the Chicago engineering firm, Pearse, Greeley, and Hansen. A report on the Annual Meeting of the Society was given by Alonzo J. Hammond, Past-President of the Society. The Juniors of the Illinois Section held their second meeting of the year on January 25. An illustrated talk on "Chicago and Its Sanitation" was given by J. M. Mercer, of the Chicago Sanitary District. In this talk Mr. Mercer outlined the development of the city. Then C. B. Burdick, Director of the Society, gave a résumé of the Annual Meeting.

ITHACA SECTION

The Ithaca Section had a dinner meeting in Willard Straight Hall on the campus of Cornell University on January 18. There were 23 present. Following a short business session, the group convened with the Cornell University Student Chapter to hear A. E. Cummings, manager of the Chicago office of the Raymond Concrete Pile Company, give an illustrated lecture on "Modern Foundation Problems." Stressing particularly the problem of settlement, Mr. Cummings showed slides of reinforced concrete buildings that had settled as much as six feet. Refreshments were served by the Student Chapter to the 65 who were present for the talk.

LOS ANGELES SECTION

On January 13 the regular monthly meeting of the Los Angeles Section took place at the University Club. On this occasion the program consisted of addresses by Harold Ryerson, director of public relations for the Merchants' and Manufacturers' Association of Los Angeles, and E. F. Scattergood, chief engineer and general manager of the Bureau of Power and Light of the Los Angeles Department of Water and Power. Mr. Ryerson gave a vivid picture of the present labor situation, dealing especially with the shipping strike. "Construction of the Boulder Dam Transmission Line" was the subject of Mr. Scattergood's address, in which he indicated some of the historical high lights leading to the construction of Boulder Dam and the transmission line. The meeting of the Junior Forum of the Los Angeles Section, which was held on the same evening, was addressed by Trent R. Dames, who is in the office of R. V. Labarre, construction and testing engineer. Mr. Dames' topic was "The Application of Soil Mechanics to the Design of Foundations on Alluvial Soils."

LOUISIANA SECTION

Officers for 1937 were elected at the annual meeting of the Louisiana Section, which was held in New Orleans on January 21. The list of these is as follows: H. A. Sawyer, president; W. H. Rhodes, first vice-president; A. J. Negrotto, second vice-president; and J. A. McNiven, secretary-treasurer. The technical program consisted of a paper on rainfall and runoff by Alfred Théard, general superintendent of the Sewerage and Water Board of New Orleans.

MILWAUKEE SECTION

A dinner meeting of the Milwaukee Section took place at the City Club on January 28. There were 25 present. The business session included the reading of several reports, including F. W. Ullius' account of the Local Section Conference held at the Fall Meeting and a statement by Ira N. Curtis, junior correspondent for CIVIL ENGINEERING. The annual election of officers, which took place at this time, resulted as follows: E. L. Knebes, president; L. J. Larson, first vice-president; J. P. Gebhard, second vice-president; and F. W. Ullius, secretary-treasurer. The Section also passed a resolution establishing awards for Student Chapters at Marquette University and the University of Wisconsin.

NEW MEXICO SECTION

There were 26 present at the annual engineers' banquet, which was held by the New Mexico Section at the Alvarado Hotel in Albuquerque on December 15. The business routine included the annual election of officers, which was reported in the February issue of CIVIL ENGINEERING. After the meeting adjourned, all present enjoyed a theater party as guests of the Section.

NORTHEASTERN SECTION

The annual meeting of the Northeastern Section took the form of a luncheon, held in Boston, Mass., on January 23. The election of officers for 1937, which took place at this time, resulted as follows: Albert Haertlein, president; John P. Wentworth, vice-president; and Francis H. Kingsbury, secretary-treasurer. Stanley Dore and H. B. Kinnison were elected members of the executive committee. Short talks were given by Harrison P. Eddy, Past-President of the Society; Arthur W. Dean, new Director of the Society; and Frank A. Barbour, retiring Director. The principal speaker was Louis C. Hill, newly elected President of the Society, who discussed his experiences in the Southwest in the construction of dams for water supply and irrigation.

PHILADELPHIA SECTION

On January 13, the members of the Philadelphia Section were guests of the civil engineering department of the Drexel Institute of Technology for a demonstration of the facilities of the college. After dinner, which was served by the home economics department, the members were divided into five groups which visited, in rotation, the points of interest. These included the concrete and testing laboratory, which is equipped with 10,000, 30,000, 100,000, and 200,000-lb tension and compression machines, both of screw and hydraulic type; the municipal laboratory with equipment used for biological and chemical tests for maintaining a good water supply and satisfactory sewage disposal; classrooms with displays of the various types of apparatus used in the mechanical analysis of stresses by the use of models; the electrical laboratory, where a spectacular demonstration of man-made lightning was given; and the chemistry laboratory, which is the last word in modern equipment and safety devices. The 70 members and guests present were rewarded by a most interesting evening. The meeting was in charge of H. L. Bowman.

ROCHESTER SECTION

On January 7 a dinner meeting of the Rochester Section was held at the University Club, with 24 present. During the business session several committee reports were heard, and the annual election of officers took place. The list of these officers is as follows: George C. Wright, president; William H. Roberts, first vice-president; and Carey H. Brown, second vice-president. Norman H. Davidson continues as secretary-treasurer. The technical program consisted of the showing of movies of miscellaneous construction projects.

SACRAMENTO SECTION

The Sacramento Section enjoyed weekly luncheon meetings during January. On the 5th the speaker was Gordon Zander, hydraulic engineer in the California State Department of Public Works, who gave a delightful illustrated lecture on a recent trip to the West Indies and South America. On January 12 the following officers were elected for 1937: Thomas B. Waddell, president; Herbert H. Hodgeson, first vice-president; Paul S. Jones, second vice-president; and Mark S. Edson, secretary. The program at the meeting held on the 19th consisted of a sound motion picture shown by O. W. Sollie, of the California Redwood Association, depicting scenes on the Mendocino County coast, including Fort Ross erected of redwood by the Russians in 1812. The speaker at the meeting held on January 26 was Charles J. Kraebel, senior silviculturist for the California Forest and Range Experiment Station of the U. S. Forest Service, who spoke on watershed management, illustrating his lecture by the use of slides. The annual dinner and dance for the newly elected officers took place at the Hotel Senator on January 14, with 142 present. During the dinner vocal selections were given by a male quartet. The after-dinner speech was given by Walter E. Stoddard, retiring president, who discussed the engineering progress made during the past year.

SAN DIEGO SECTION

There were 13 present at a meeting of the San Diego Section, which took place on January 28. After a business meeting, during which committees for the new year were announced, President Mills introduced Chesney R. Moe, of the physics department of San Diego State College. Professor Moe gave an interesting and informative talk on gyroscopes. By means of a revolving pedestal and weights he illustrated the principles used in the design of these instruments, and by the use of models he showed how they function as ship stabilizers and in compasses.

ST. LOUIS SECTION

There were 40 members and guests present at the regular monthly meeting of the St. Louis Section, which was held at the Mayfair Hotel on January 25. The speaker of the occasion was J. Lionberger Davis, president and chairman of the board of the Security National Bank of St. Louis, who emphasized the fact that engineers should not let civic responsibility rest upon the shoulders of business men. Engineers, he pointed out, could give the logical and proper direction to civic movements and thus keep them from failing. The Section then passed a resolution to be forwarded to the governor urging the appointment of an engineer to the Public Service Commission.

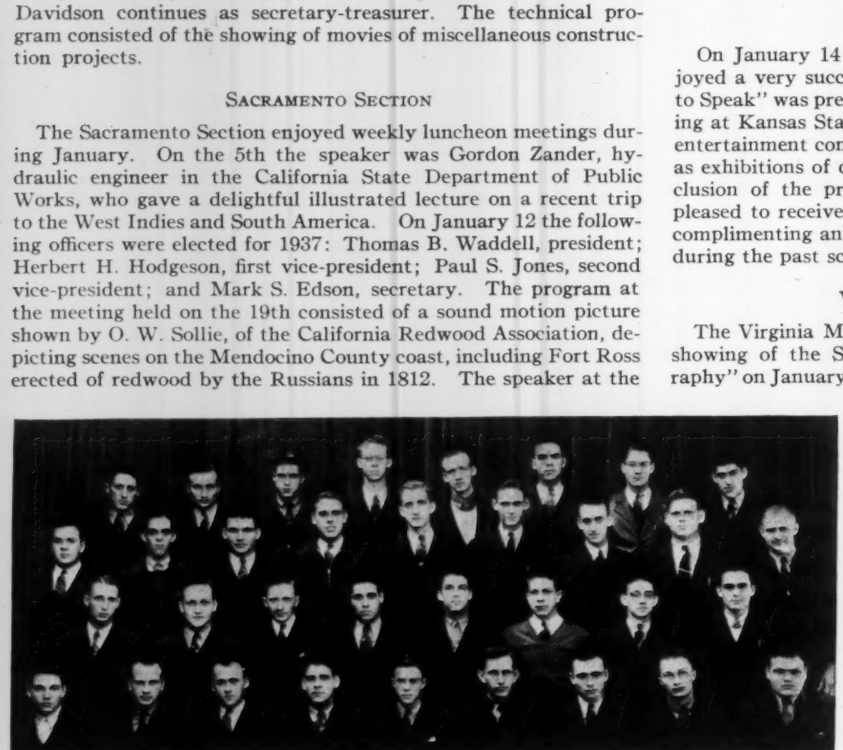
Student Chapter Notes

KANSAS STATE COLLEGE

On January 14 the Kansas State College Student Chapter enjoyed a very successful smoker. A talk on "Teaching Engineers to Speak" was presented by K. V. Given, professor of public speaking at Kansas State College. This was followed by a program of entertainment consisting of orchestral and piano selections as well as exhibitions of dancing. Refreshments were served at the conclusion of the program. Members of the Chapter were much pleased to receive a letter from Past-President Daniel W. Mead, complimenting and commending the Chapter for its achievements during the past school year.

VIRGINIA MILITARY INSTITUTE

The Virginia Military Institute Student Chapter sponsored the showing of the Society's illustrated lecture on "Aerial Photography" on January 14 and 15. Over 90 students saw these slides.



UNIVERSITY OF NEBRASKA STUDENT CHAPTER

UNIVERSITY OF NEBRASKA

During the past semester the University of Nebraska Student Chapter held seven meetings. The Society's illustrated lectures on "The Catskill Water Supply," "Mississippi Flood Control," and "Norris Dam" were shown at three of these sessions, the accompanying talks being given by E. De Klotz, K. B. Schroeder, and Kenneth Clark, respectively. At other meetings various members of the faculty spoke on timely engineering topics. On November 18 motion pictures of the Student Chapter's summer camp were shown, and there was a dinner meeting on December 16. One of the features of the meeting, held on January 20 was the installation of officers for the 1937 school year.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for April

AMONG THE ARTICLES scheduled for the April issue is one by Arthur E. Morgan, M. Am. Soc. C.E., chairman of the Tennessee Valley Authority, on the subject of planned utilization of water resources. Water control is a public and not a private function, and an effort should be made to coordinate special usages such as navigation, flood control, irrigation, recreation, water supply, and power development. The country needs legislation which will permit unified development of water resources, and this may take the form of constitutional amendment or interpretation, organizations of interstate water-control districts, or compacts between the states. The Tennessee Valley Authority has illustrated what can be done in planning the unified development of one great river system for navigation, flood control, and power, and it is possible to extend this type of planning to other systems.

A second article, by Clair V. Mann, M. Am. Soc. C.E., head of the department of engineering drawing at the Missouri School of Mines, discusses the entire profession of engineering from a generic standpoint. Touching in turn upon the nature, goal, content, and origin of engineering, the paper includes some interesting data on the reasoning faculty in higher animals as well as speculation on the probable activities of the earliest engineers. It endeavors to define engineering in its relationship to other branches of knowledge, and concludes with a subdivision of the profession both functionally and with respect to its various fields.

A fourth paper on the life and works of Thomas Telford, pioneer in bridge, road, and canal construction, by J. F. Baker, professor of civil engineering at the University of Bristol, England, and John Armitage, is also scheduled for the April number of CIVIL ENGINEERING. This concluding article deals with Telford's bridge construction from about 1814 to the time of his death in 1834. The most important of the bridges built by Telford were the Menai Straits and the Conway River suspension spans. The former, with a span of 580 ft, connects Anglesey with the mainland of Wales. While this was not the first suspension bridge to be built, it is one of the most striking ever erected, and exceeds in length all previous spans of its type by over 100 ft. In recognition of this and other outstanding achievements, Telford in 1820 was elected as first president of the Institution of Civil Engineers.

If space permits, there will be included an article on the construction of a subway in Osaka, Japan, prepared by Y. Totake, consulting engineer to the Tokyo Underground Railway Company. Difficult soil conditions necessitated special methods to carry the subway structures under the numerous rivers and canals, and also to prevent the loss of water-borne silt from behind the sheeting in certain locations far from watercourses. Two and one-half miles of two-track subway were put into operation in 1935, and construction of another $2\frac{1}{2}$ miles is being actively pushed.

Art in Engineering

MOST engineering structures are built to serve man, so their primary function is that of utility. More and more, however, thought is being given also to their esthetic values so that they may serve the further purpose of enhancing the appearance of a community, state, or even a country as a whole. To promote such artistic developments CIVIL ENGINEERING has pictured in previous numbers examples of construction which approach that ideal.

On the page of special interest, page 5 of this issue, appears a picture of a structure from a foreign land which seems to fulfil admirably the requirements for esthetic design in that country. A description of this water tower and its surroundings at Yenching University in China is given in an accompanying article. In the future, also, CIVIL ENGINEERING plans to portray other engineering structures from this and foreign countries which might be considered as forming a series entitled "Art in Engineering." These will appear from time to time on the page of special interest.

Wise and Otherwise

DURING HIS TRAVELS, Professor Abercrombie encountered a tribe of aborigines of whom by reputation some had red feet and others white. All those with red feet invariably told the truth, while those with white feet invariably lied. On a certain occasion Professor Abercrombie approached one of three aborigines and asked him what color feet he had. The reply was in a strange tongue unintelligible to the Professor, who thereupon turned to the second native and asked him what the first had said. The second replied, "He says he has red feet." Turning now to the third, the Professor asked him what color feet the second one had. The reply was, "He has white feet." What color feet had the third aborigine? This problem is based upon one appearing in a recent issue of *The Kalends*, house organ of the Waverly Press of Baltimore, Md., to which credit is hereby given.

February's problem was as follows: "A rope weighing 2 oz per ft hangs freely over a pulley. A weight is attached to one end, balanced by a monkey on the other. The combined ages of the monkey and its mother are 4 years, and the weight of the monkey is as many pounds as the mother is years old. The mother is twice as old as the monkey was when the mother was half as old as the monkey will be when the monkey is three times as old as its mother was when she was three times as old as the monkey was. The weight of the rope and the weight is half as much again as the difference between the weight of the weight and the weight of the weight plus the weight of the monkey." The length of the rope was required.

In solving this problem, let a equal the present age of the mother, the weight of the weight, and the weight of the monkey. Then $4 - a$ equals the present age of the monkey. Also, if b equals the age of the mother when she was 3 times as old as the monkey, then $\frac{b}{3}$ will represent the age of the monkey at that time.

Then $a - b = (4 - a) - \frac{b}{3}$ . . . . . [1]

Now when the monkey is 3 times his mother's age at the time she was 3 times his previous age, his age will be $3b$. Also, at some time previous to the present, when the monkey's age was $\frac{a}{2}$, the mother's age was $\frac{3b}{2}$.

Then $a - \frac{3b}{2} = (4 - a) - \frac{a}{2}$ . . . . . [2]

From Eqs. 1 and 2, $a = 2.5$ years or pounds.

Let c equal the length of the rope in feet. Then $\frac{2c}{16}$ will represent its weight in pounds, and from the last sentence of the problem,

$$\frac{2c}{16} + a = \frac{3}{2}\left[(a + a) - a\right] \quad . . . [3]$$

From Eq. 3, $c = 4a$, and the rope is 10 ft in length.

Suggestions for other problems for Professor Abercrombie's column, accompanied by solutions, may be addressed to the editor. Solutions should preferably be sent in separate enclosed envelopes.

American Institute of Consulting Engineers Elects Officers

AT A MEETING of the Council of the American Institute of Consulting Engineers, which was held in New York City on January 19, 1937, Edwin F. Wendt, M. Am. Soc. C.E., consulting engineer of Washington, D.C., was reelected president. Robert Ridgway, Past-President and Honorary Member of the Society, was elected vice-president, and Philip W. Henry, M. Am. Soc. C.E., secretary and treasurer. Both are consulting engineers in New York City.

The Neckar Canal

By JOHN HEDBERG, JUN. AM. SOC. C.E.
FREEMAN SCHOLAR, 1936–1937

IN THE COURSE of my studies as Freeman Scholar of the Society I have had an opportunity to visit a number of important hydraulic projects in Germany. Among them, the Neckar Canal is of especial interest. For many years plans have been afoot to promote commercial navigation on the Neckar River from its confluence with the Rhine at Mannheim past the ancient city of Heidelberg to the industrial center around Stuttgart. In a larger sense these plans have visualized the Neckar development as part of a great canal system embracing the Rhine-Danube-Rhone-Marne river systems (Fig. 1). It is conceded, however, that even if the major scheme is never completed, the Neckar Canal (Fig. 2) will be an entirely feasible undertaking by itself.

In some ways the introduction of navigation on the Neckar may be considered a reversion to old times. From the middle ages up to 1850, commerce on the unregulated river enjoyed a continuous and prosperous growth. But with the coming of the railroads, river traffic began a rapid decline until 1879, when it came to a complete stop.

It was not a question of economy of transportation that enabled the railroads to take away business from the river. It was their speed and dependability. With the flow of the Neckar varying from 706 to 170,000 cu ft per sec at Heidelberg, and with a gradient of 4 ft to the mile, navigation was impossible during some seasons and undependable in the others.

Toward the end of the last century and the beginning of the present, industrialists at Stuttgart and its vicinity, feeling the pinch of competition from more favorably situated regions such as the Ruhr, began to study the problem of cheaper transportation of raw materials and goods in and out of their district. The result of their efforts was a plan for regulation of the Neckar from Mannheim to Plochingen.

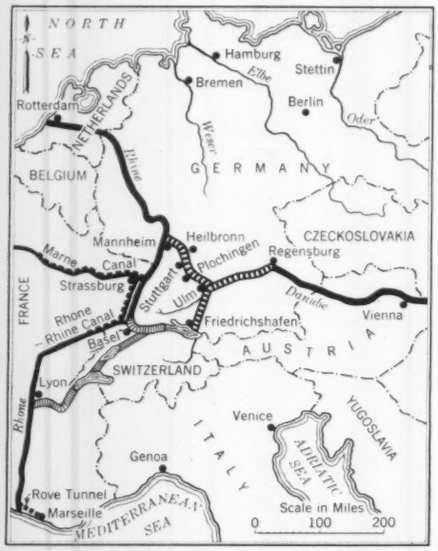


FIG. 1. CENTRAL EUROPE, SHOWING, IN BROKEN LINES, THE POTENTIAL CANALS LINKING THE RHINE AND THE DANUBE

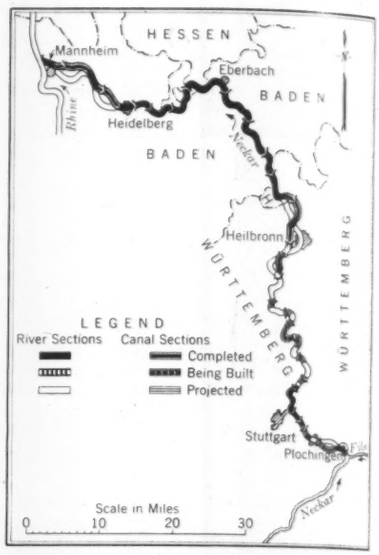


FIG. 2. PRESENT STATUS OF THE NECKAR CANAL, CONNECTING MANNHEIM AND PLOCHINGEN

The World War interrupted this work but also emphasized the need for better transportation facilities. In 1921 construction actually started, but the succession of currency inflation, reparations, and depression hampered progress greatly. It was not until 1933 that construction was enabled to progress rapidly. At the present time (1936) fully two-thirds of the work has been done and commercial navigation has become active between Mannheim and Heilbronn.

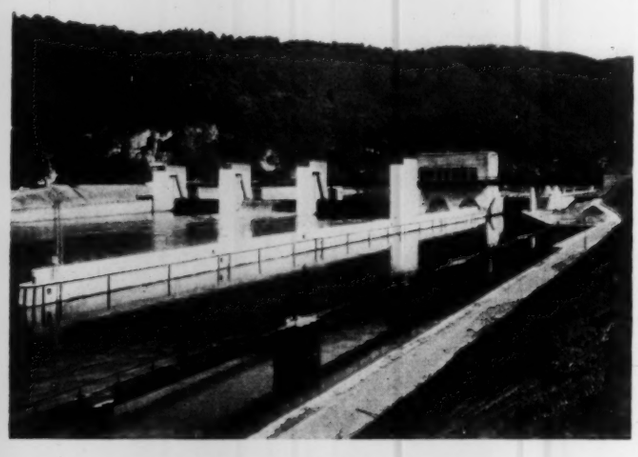
The engineering features of this work are especially interesting. In order to regulate the stream to a minimum depth of 8.2 ft for canal boats of 1,200 tons, it was necessary to construct no less than 26 low dams in a distance of 131 miles. The plan of these structures is shown in Fig. 2.

Each of the 26 dams incorporates movable weir crests and single or double canal locks 362 ft long and 39.3 ft wide. At 20 of the dams, power plants have been installed which will develop a yearly average of 44,000 kw. At each of the dams the water level is raised on an average of 20 ft.

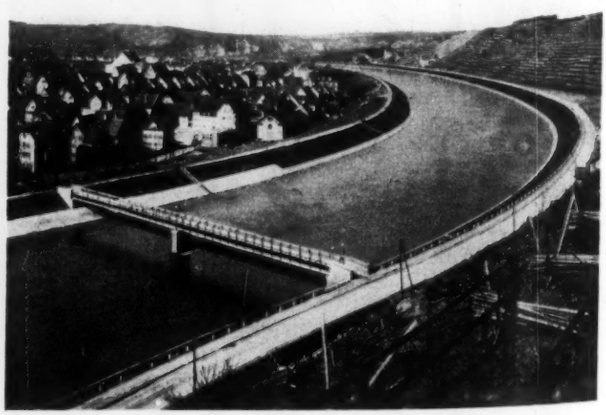
Another feature of the project has been the regulation of the river along its banks. It was necessary to build many miles of levees to prevent flooding of the land above the dams. These levees were built sufficiently high so that in conjunction with the operation of the movable weir crests, flood control was accomplished. It has been estimated that 3,700 acres have been relieved from flood danger; much of this area was municipal or industrial.

The total cost of the project at the present rate of exchange (1 mark = 40 cents) is estimated at $98,000,000, of which $61,000,000 had been spent by the end of 1935. The actual costs appear to have agreed well with the estimates.

While inspecting some of these structures, I noticed an additional feature not readily evaluated. The production of



A DAM ON THE NECKAR CANAL
Power Plant Between Weir and Lock



NEW LEVEES ALONG THE NECKAR
To Protect Municipal and Industrial Areas

quiet reaches of water upstream from the dams had stimulated the promotion of municipal bathing and boating facilities in the towns along the Neckar. Near Stuttgart one of these new beaches is said to have accommodated over 10,000 people on some warm days. How many of our projects in America combine so many features in one—navigation, power, flood control, and "boondoggling?"

Arc Welding Foundation Offers Substantial Prizes for Practical Papers

TO STIMULATE intensive study of arc welding, $200,000 will be distributed by the James F. Lincoln Arc Welding Foundation among winners of 446 separate prizes for papers dealing with arc welding as a primary process of manufacture, fabrication, or construction in 11 major divisions of industry. The principal prize winner will receive not less than $13,700. Other prizes range from $7,500 to $100, the latter sum to be awarded each of 178 contestants whose papers are adjudged worthy of honorable mention.

Of especial interest to civil engineers are the "structural" and "containers" divisions. In the former, 24 prizes are offered, with a total value of $14,200. Four subclassifications are established in this division, namely, "buildings," "bridges," "houses," and "miscellaneous." In the "containers" division, there will be 14 prizes with a total value of $10,500. The subclassifications are "contents stationary" and "contents moving."

Papers must either describe the re-design of an existing machine, structure, building, etc., so that arc welding may be applied to its manufacture; or they must present a design (either in whole or in part) of a machine, structure, building, etc., not previously made—the description to show how a useful result, impractical with other methods of construction, is obtained by arc welding.

Contestants must have papers in duplicate on file with the Secretary of the Foundation, at Cleveland, Ohio, not later than June 1, 1938. Prospective entrants should communicate promptly with Foundation Secretary A. F. Davis, P. O. Box 5728, Cleveland, for complete details of the rules and conditions covering awards.

Two Society Members Speak at Institution of Chemical Engineers

TWO MEMBERS of the Society—Harry H. Hendon, sanitary engineer of Jefferson County, Alabama, and Dr. Karl Imhoff, of Germany—were among the guests invited to participate in a symposium of the Institution of Chemical Engineers, which was held in London on February 17, 1937. Mr. Hendon, whose paper dealt with the subject of the chemical treatment of sewage in America, is remaining abroad for a few weeks in order to study stream pollution and treatment methods in England and on the Continent.

A Colorful Chinese Water Tower

By H. K. BARROWS, M. AM. SOC. C.E.

PROFESSOR OF HYDRAULIC ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, AND CONSULTING ENGINEER, BOSTON, MASS.

ANY INTERESTING treatment of an engineering structure commands notice, whatever the subject or the location. As an example, I call attention to a beautiful water tower, of Chinese architecture, located at Yenching University, Peiping, China, and constructed in 1921.

VISTA OF THE UNIVERSITY CAMPUS
Water Tower Is Exact Replica in Appearance of Famous Old Pagoda

This tower or pagoda is shown in the accompanying view and also on the page of special interest. It is about 150 ft high and 30 ft in diameter, with 13 projecting roofs. It is founded upon 188 reinforced concrete piles, 11 ft long, driven close together, and is constructed of reinforced concrete, 1:2:4 mix, using native manufactured cement and local stone and sand. Post scaffolding and stagings were built up gradually, as needed, and the concrete was mixed by hand at the working level with materials hauled up by the workmen. It took two years to build. Brackets and lookout rafters under the eaves, as well as the multiple roofs, are all of precast reinforced concrete.

In the tower are two reinforced concrete tanks (accessible by a spiral stairway), each about 20 ft in diameter by 15 ft high, one for cold water supply and the other for treated water for boiler and the hot bath-water system of the university. The cost of the tower was about $33,000 (U. S. currency).

The water supply is from a 6-in. well 140 ft deep, with two motor-operated pumps of 180 gal per min capacity. Water is pumped to a settling tank, treated with lime to reduce hardness, filtered, and pumped to the tower. The yearly use is about 35 million gal for 1,500 persons, or about 63 gal per capita per day.

Yenching University is one of the leading educational institutions in China, with a faculty of about 100, a student body of over 800, an annual budget of over $300,000, and a campus now well toward completion under a building program involving an initial expenditure of nearly two million dollars.

Yenching has the active support and cooperation of several American universities. These include the Harvard-Yenching Institute, which aims to promote, both in China and America, graduate study and research in the various branches of Chinese culture and to encourage the Chinese to study their own civilization and to interpret this to the West. Princeton, with an exchange program of professors under the Princeton-Yenching Foundation, sponsors an educational program in the social sciences of profound influence upon Chinese life.

Since 1929, the School of Journalism of the University of Missouri has been cooperating with Yenching in providing education for the profession of journalism in China. Wellesley is also closely tied to Yenching in interest and cooperative service, and several of the Wellesley faculty have been in residence there.

The property of Yenching University is held in trust, with administrative authority, by a board of trustees with headquarters in New York City. Local administration is under a board of managers, of whom two-thirds are Chinese. The writer is indebted for the material for these notes to Dr. N. Gist Gee, vice-president of the University.

Brief Notes

THE LOS ANGELES Engineering Council, composed of representatives of the various professional groups in the city, has petitioned the city council and the mayor to insist that the position of head of the department of building and safety, recently made vacant by the death of the incumbent, be filled only by a registered engineer or architect. None of the several early candidates for the position was so qualified, and the Engineering Council therefore urged that political expediency be set aside in the interest of safety.

* * * *

THE AMERICAN Public Works Association, formerly the American Society of Municipal Engineers and the International Association of Public Works Officials, has announced the election of Thomas Buckley as president; J. E. Root, first vice-president; Guy Brown, second vice-president; and John Flockhart, treasurer. Two of this group, Messrs. Buckley and Root, are members of the Society.

NEWS OF ENGINEERS

Personal Items About Society Members

FELIX J. KEAVENY is now structural designer for Max B. Miller and Company, of New York City. He recently completed a temporary appointment as structural designer in the department of operation and maintenance of the Panama Canal.

E. J. NEMMERS, formerly an assistant engineer in the U. S. Bureau of Reclamation, is now in the construction department of the Rock Island (Ill.) office of the Standard Oil Company.

JAMES H. LE VAN, passed assistant sanitary engineer in the U. S. Public Health Service, has been transferred from Cincinnati, Ohio, to Chillicothe, Ohio, where he has been detailed as officer in charge of the Scioto River investigation.

CHARLES W. MORRISON has been made vice-president in charge of the appraisal department of the Cross and Brown Company at 270 Madison Avenue, New York. Mr. Morrison was previously real estate appraiser for Joseph P. Day, Inc., of the same city.

HERBERT DEAKYNE, Brig.-Gen., Corps of Engineers, U. S. Army (retired), has been engaged by the Trinity River Canal Association to prepare its new engineering report to be submitted to the army engineers. His headquarters are now at Fort Worth, Tex. Since his retirement from active service in 1931 General Deakyne has spent most of his time on river and harbor consultation.

C. W. MATTHEWS recently resigned as town planner for the Suburban Resettlement Division in Washington, D.C., where he was in charge of the design of streets for the Greendale project, near Milwaukee, to accept a graduate research scholarship in city planning at Massachusetts Institute of Technology. While in Boston, Mr. Matthews is doing research work on the Connecticut River basin in the office of the New England Regional Planning Commission.

E. M. FLEMING, who has been district manager in charge of the New York office of the Portland Cement Association since 1935, has been appointed regional manager of the eastern offices of this organization. His headquarters are still in New York.

GEORGE L. FREEMAN has become a partner in the consulting engineering firm of Moran and Proctor, New York City. The firm name is now Moran, Proctor, and Freeman.

J. LESTER WHITE is now chairman of the Louisiana State Planning Commission, which was created by Act 36 of the regular session of the 1936 legislature. The offices of the Commission have been established in the State Capitol Building in Baton Rouge, La.

HAROLD E. WESSMAN, associate professor of structural engineering and mechanics at the University of Iowa, was recently appointed professor of structural engineering at New York University, effective in the fall of 1937.

JOHN C. PAGE has been appointed Commissioner of Reclamation in the U. S. Department of the Interior by Secretary Harold I. Ickes. Mr. Page has been acting commissioner since the death of the late ELWOOD MEAD, M. Am. Soc. C.E., which occurred on January 26, 1936.

JOHN C. PAGE

Except for one brief intermission, he has been connected with the U. S. Bureau of Reclamation since 1909. During this period he served the Bureau as engineer and assistant superintendent on the Grand Valley project and later as chief administrative assistant to the engineer of construction on Boulder Dam.

JEROME M. RAPHAEL, an inspector in the U. S. Engineer Office, has been transferred from the Tygart River reservoir dam, at Grafton, W.Va., to detached duty at the Massachusetts Institute of Technology, where he is making a stress analysis of Tygart Dam.

GEORGE R. RICH has resigned as senior engineer in the U. S. Engineer Office at Boston, Mass., to become head structural engineer for the Tennessee Valley Authority with headquarters at Knoxville, Tenn.

A. W. NEWTON, chief engineer of the Chicago, Burlington and Quincy Railroad Company, was recently retired after thirty-four years of service with this company. He will be retained as consulting engineer.

FRANCIS J. HANRAHAN, formerly an instructor at Pennsylvania State College, is now with the National Lumber Manufacturers' Association, in Washington, D.C.

AHMED M. SIJAN has resigned as assistant engineer with the Iraq Petroleum Company, Ltd., to become a civil engineer for the Ministry of Economics and Communications of the Iraq Government. His present post is inspector of public works for the Euphrates district of the public works department of the ministry. His headquarters are in Baghdad, Iraq.

WILLIAM H. MUESER, resident engineer for Moran and Proctor, consulting engineers of New York City, has been admitted to partnership in the firm. As previously noted, the firm name will be Moran, Proctor, and Freeman.

EBEN G. HITCHINGS was recently transferred from the U. S. Engineer Office in San Francisco, Calif., to the San Francisco office of the National Park Service, where he is an associate civil engineer.

FRANK T. DARROW has been appointed chief engineer of the Chicago, Burlington and Quincy Railroad Company, with headquarters in Chicago, Ill. He was previously assistant chief engineer for this company at Lincoln, Nebr.

HARRY WIERSEMA is now acting general office engineer for the Tennessee Valley Authority. Mr. Wiersema has been with the Authority since its early days, and has been employed in a number of different capacities.

LEO CROWLEY, who is in the Detroit (Mich.) city engineer's office, has been advanced to the position of assistant civil engineer of the survey division of this office.

FLOYD W. HOUGH, formerly an associate geodetic engineer in the U. S. Coast and Geodetic Survey, Washington, D.C., has been transferred to the U. S. Engineer Office at Pittsburgh, Pa.

FRANKLIN F. SMITH has entered the employ of Hungerford and Terry, Inc., of Clayton, N.J., as a designer of filters and water softeners.

O. LAURGAARD has been promoted to the position of construction engineer on Hiwassee Dam for the Tennessee Valley Authority. He was formerly general office engineer for the Authority.

FORREST WEBER is now engineer of sewer maintenance and construction for Detroit, Mich. He was previously acting engineer.

PERCY A. SHAW, superintendent and engineer of the Manchester (N.H.) Water Works, has been appointed by the governor as engineer member of the New Hampshire State Board of Health.

JAMES B. HAYS, formerly with the U. S. Bureau of Reclamation in Denver, Colo., was recently appointed construction engineer for the Tennessee Valley Authority on the Chickamauga Dam project.

PETER J. STUPKA has resigned as traffic safety engineer for the American Automobile Association to become connected jointly, with the U. S. Bureau of Public Roads and the Highway Research Board in conducting a research project in traffic accident reporting.

WILLIAM P. LIPSCOMB has recently been made manager of the Richmond (Va.) district of the Ingot Iron Railway Products Company, with headquarters in Richmond.

W. V. BARRY, who for several months has been serving as acting city engineer of New Haven, Conn., has been appointed city engineer, succeeding the late EDWARD S. NETTLETON.

TSU-YI CHEN is now associate director and assistant chief engineer of the Chengtu-Chungking Railway, with headquarters in Chungking, China. He was formerly district engineer-in-chief for the Tientsin-Pukow Railway, at Pukow, China.

HURLBUT SAYLOR JACOBY, previously with the American Radiator and Standard Sanitary Manufacturing Company, of Springfield, Mass., is now in the engineering sales division of the U. S. Gypsum Company in Chicago, Ill.

WILLIAM HENRY WILSON has entered the employ of the Tennessee Electric Power Company at Chattanooga, Tenn., where he is in the engineering department. He was formerly PWA engineer in Nashville, Tenn.

MERRILL BERNARD, hydraulic engineer of Washington, D.C., has been made chief of the river and flood division of the U. S. Weather Bureau, with headquarters in the same city.

DECEASED

CHARLES CHAPMAN ANTHONY (M. '07) of Mill Valley, Calif., died on November 15, 1936. Mr. Anthony was born at Lockport, N.Y., on September 23, 1863, and educated at Cornell University. From 1884 to 1890 he was employed on telephone work and incandescent lamp testing. In 1895, after experience in railroad signaling, he entered the employ of the Pennsylvania Railroad, where he received several promotions, finally becoming assistant signal engineer. In 1916 he resigned and moved to California where he engaged in business as a consulting signal engineer. Mr. Anthony was the inventor of several railroad engineering devices and a contributor to railroad periodicals.

TIMOTHY RALPH ATKINSON (M. '11) city engineer of Bismarck, N.D., died there on January 27, 1937, at the age of 68. Mr. Atkinson was born at North Anson, Me., and was educated at the University of Maine. In 1899, after six years' experience in railroad work in New England, he became manager of the By-Products Paper Company at Fargo, N.D. From 1903 to 1905 he was city engineer of Fargo. He served as state engineer of North Dakota from 1907 to 1913 and as city engineer of Bismarck, N.D., from 1907 until his death. He also maintained a consulting practice in Bismarck. Mr. Atkinson was responsible for the design and construction of numerous water-works and sewerage systems in North Dakota.

HARRY CHESTER BOYDEN (M. '08) consulting engineer of Berkeley, Calif., died on October 25, 1936. Mr. Boyden was born in Readville, Mass., on April 23, 1873, and graduated from Worcester Polytechnic Institute in 1894. From 1895 to 1902 he was a surveyor in the engineering department of the Boston and Albany Railroad, and from the latter year until 1908 was assistant engineer for the Delaware, Lackawanna and Western Railroad. Later he was employed as highway commissioner for the state of California, as assistant engineer for the J. G. White Engineering Company, and as dean of the college of engineering of Ohio Northern Institute. A few years ago he established a consulting practice in Berkeley. During the war Mr. Boyden served as a major in the Corps of Engineers, U. S. Army.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

MELVIN DAVID CASLER (M. '16) assistant engineer for the Port of New York Authority, died at Mount Vernon, N.Y., on January 27, 1937. He was 55. Mr. Casler was born at Bordentown, N.J., and graduated from Union College in 1906. From 1907 until 1920 he was with the New York Board of Water Supply in a variety of capacities. He was then with the Westchester County Park Commission for five years and, later, was designing engineer for the Hudson River Regulating Board. In 1931 Mr. Casler became assistant engineer with the Port of New York Authority.

LUTHER DEAN (M. '98) consulting engineer of Taunton, Mass., died on January 9, 1937. He was born in 1867 and was educated at the Massachusetts Institute of Technology. As city engineer of Taunton from 1893 to 1897, Mr. Dean designed and supervised the construction of all street and sewer work for the city. In the latter year he was also county engineer, in which capacity he supervised the construction of bridges. From 1898 until his death he maintained a consulting practice in Taunton.

JOHN JOSEPH DONOVAN (M. '88) vice-president of the Bloedel-Donovan Lumber Mills at Bellingham, Wash., died in that city on January 10, 1937. Mr. Donovan, who was 79, was born in Rumney, N.H. In 1882, following his graduation from Worcester Polytechnic Institute, he became connected with the Northern Pacific Railway, being in charge of construction in Montana for this railroad in 1887 and 1888. Later he was chief engineer and manager of three railroads radiating from Bellingham. Since 1906 Mr. Donovan had been engaged in the lumber business in Bellingham—first as vice-president of the Larson Lumber Company, and later as vice-president of the Bloedel-Donovan Lumber Mills, one of the largest companies of its kind in the United States.

LAURENCE COOPER HOUGH (M. '29) district manager of the Pitometer Company, Albany, N.Y., died at Savannah, Ga., on January 13, 1937. He was born at Falls Church, Va., on December 5, 1891, and graduated from Cornell University in 1914. From the latter year until 1917 he was engaged as a junior engineer on subway construction for the New York Public Service Commission. In 1918, after service in France as a second lieutenant with the coast artillery, he became connected with the Pitometer Company.

WILLIAM BENJAMIN JACKSON (M. '03) retired rate engineer and consultant for the New York Edison Company, died in Pittsfield, Mass., on January 20, 1937, at the age of 67. Mr. Jackson was born at Kennett Square, Pa., and graduated from Pennsylvania State College in 1890. After several years with the Stanley Electric Manufacturing Company, of Pittsfield, he became manager of the Lowell Water and Light Company, and later of the Peninsular Light and Power Company. He was then special engineer abroad for the Stanley Company. From 1902 until 1918 Mr. Jackson was a member of the engineering firm of D. C. and William B. Jackson, of New York City. He was with the New York Edison Company from 1919 until three years ago, when illness forced his retirement to his farm at Pittsfield. In 1918 he served in the U. S. Army, with the rank of major.

BURDETT KIPP (M. '20) chief engineer of Atwell-Gustin-Morris, Inc., of Long Island City, died in New York City on January 23, 1937, at the age of 62. Mr. Kipp was born in New York City and graduated from Columbia University in 1898. From 1900 to 1906 he was with the Rapid Transit Commission. He then became connected with the Degnon Contracting Company, where he remained for many years—first, as principal assistant engineer and, later, as resident engineer on the construction of various parts of the I.R.T. subway in Manhattan. Finally he became chief engineer of Atwell-Gustin-Morris, Inc., which is now driving one of the shafts for the Manhattan-Queens vehicular tunnel.

EDWARD HERVEY LEE (M. '00) former president of the Chicago and Western Indiana Railway and the Belt Railway of Chicago, died in that city on January 11, 1937. He was 73. Mr. Lee was born in Dayton, Ohio, and educated at Ohio University and the University of Wooster. From 1880 to 1898 he served as assistant, principal assistant, and chief engineer of various railroads, including the Nickel Plate; the Union Pacific; and the Elgin, Joliet, and Eastern. In 1898 Mr. Lee joined the staff of the Chicago and Western Indiana Railway and the Belt Railway of Chicago. Here he advanced successively from engineer to president. He retired in 1931.

GEORGE ISRAEL OAKLEY (M. '22) assistant engineer of design for the New York City Department of Sanitation, died at

Port Washington, N.Y., on November 6, 1936. Mr. Oakley was born at Roslyn, N.Y., on August 14, 1878, and graduated from Union College in 1902. After early work on topographical surveys, he became assistant engineer and resident engineer on the construction of the New York State Barge Canal, remaining there from 1905 to 1915. He was city engineer of Little Falls, N.Y., from 1915 to 1917; an engineer for several New York City engineering firms from 1917 to 1922; and with the J. G. White Engineering Corporation from 1922 to 1930. Later he was assistant engineer for the New York City Board of Water Supply.

JOHN JUNIOR WILSON (Assoc. M. '13), of Boulder, Colo., died on November 21, 1936, at the age of 58. Mr. Wilson was born at Georgetown, Colo., and educated at the University of Colorado. From 1904 to 1907 he was employed as a mining engineer by several mining companies in Colorado and Arizona. From 1907 to 1909 he was construction engineer for the Teziutlan Copper Company, of Pueblo, Mexico, and from 1909 to 1912 he was state inspector of dams. In the latter year he established a consulting practice in Boulder, and later he was chief engineer of the Primos Mining and Milling Company, of Lakewood, Colo.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From January 10 to February 9, 1937, Inclusive

ADDITIONS TO MEMBERSHIP

ARKSEY, WILBERT FOSTER (Jun. '36), Research Asst., Univ. of Minnesota (Res., 901 East River Rd.), Minneapolis, Minn.

ARMSTRONG, ELLIS LEROY (Jun. '36), Concrete Insp., U. S. Bureau of Reclamation, Bridgeland, Utah.

AUSTIN, ROBERT EDWARD (Jun. '36), 2405 Marie St., Jacksonville, Fla.

AYRE, ROBERT STEVENSON (Jun. '36), Box 2782, Stanford University, Calif.

BEARSE, IRVING WOOD (Jun. '36), 145 School St., Hyannis, Mass.

BLAKE, WARNER PAUL (Jun. '36), Care, State Highway Dept., Marshall, Minn.

BOLLEN, FLOYD LOWELL (Assoc. M. '37), Asst. to Project Engr., PWA, Platte Val. Public Power and Irrig. Project (Res., Mohawk Apartment L), North Platte, Nebr.

BOYER, JOHN PARKE (Jun. '36), 1859 East Wood St., Decatur, Ill.

BOYLAN, JOHN DUDLEY (Jun. '36), Apprentice Eng. Draftsman, Dams Div., TVA, Knoxville, Tenn.

BRANDT, HARVEY THEODORE (Jun. '37), Care, Dept. of Building, Los Angeles County (Res., 1240 West 90th Pl.), Los Angeles, Calif.

BRANDT, JOHN NICHOLAS (Assoc. M. '37), Junior Engr., U. S. Engr. Office, Missouri River Div., 610 Postal Telegraph Bldg., Kansas City, Mo.

BRENNAN, ARTHUR (Jun. '36), Browning, Mont.

CASAGRANDE, ARTHUR (Assoc. M. '37), Asst. Prof., Civ. Eng., Graduate School of Eng., Harvard Univ., Cambridge, Mass.

CHRISTIANI, HENNING OLDENBURG (Jun. '36), Engr., Madigan-Hyland, 521 Fifth Ave. (Res. Shelton Hotel, Lexington Ave. at 49th St.), New York, N.Y.

CIPOLLA, ARTHUR SAFFORD (Jun. '36), 15 Brunswick Rd., Montclair, N.J.

COONAN, LAWRENCE BERNARD (Jun. '36), 3879 Flatlands Ave., Brooklyn, N.Y.

COVELL, WILLIAM EDWARD RAAB (M. '37), Lt.-Col., Corps of Engrs., U. S. A. Dist. Engr., U. S. Engr. Office, 925 New Federal Bldg., Pittsburgh, Pa.

CROOK, LEONARD THOMAS (Jun. '36), Care, Bureau of Reclamation, Fort Sumner, N.Mex.

CSENDES, FRANCIS EMILE (Jun. '36), 45-45 Forty-Seventh St., Woodside, N.Y.

DAILY, EUGENE JOSEPH (Jun. '36), 4411 Harrison St., Kansas City, Mo.

DANIELLS, PERCY HIRAM (M. '37), Engr. in Chg., Bureau of Plans and Surveys, State Highway Dept., 1209 Elmerine, Jefferson City, Mo.

DEAKYNE, ELWOOD STAATS (Assoc. M. '36), Engr., PWA, City Hall, Salisbury, Md.

DIRZULAITIS, JOSEPH JAMES (M. '36), Senior Hydr. Engr., U. S. Geological Survey; Chf. Engr., Div. of Water Resources and Power, State Comm. on Conservation and Development, Box 1365, University, Va.

FALES, KENNETH FRANK (Jun. '36), 44 Franklin St., Medford, Mass.

FAY, EDWARD CHARLES, JR., (Jun. '37), 329 Shadeland Ave., Drexel Hill, Pa.

FIFIELD, MYRON FICKAS (Jun. '36), With Standard Oil Co. of Texas, 1111 Terrace, El Paso, Tex.

FINDEISEN, JOHN GEORGE, JR., (Jun. '36), Apprentice Engr., Caterpillar Tractor Co. (Res., 1310 Main St.), Peoria, Ill.

FISHER, RICHARD EVAN (Jun. '36), 22 Sturges Ave., Mansfield, Ohio.

FITCH, GILBERT ARTHUR (Jun. '36), Bin 151, Yuma, Ariz.

FLOYD, HAROLD SHEELER (Jun. '36), Junior Draftsman, The Lummus Co., 50 Church St., New York, N.Y. (Res., 173 Cedar Ave., Hawthorne, N.J.).

FREEBOROUGH, BENJAMIN BONNETT (Assoc. M. '37), Inventory Mgr., Statewide Highway Planning Survey, Box 201 (Res., 2907 Beanna St.), Austin, Tex.

GARRELTS, JEWELL MILAN (Assoc. M., '37), Associate in Mechanics, Columbia Univ., New York (Res., 35-22 Eighty-Eighth St., Jackson Heights), N.Y.

GIBSON, WILLIAM CHARLES (Jun. '36), Care, Allegan County Health Dept., Allegan, Mich.

GILBERT, JOHN MILES (Jun. '37), Draftsman, Russell & Axon (Res., 4021 A Greer Ave.), St. Louis, Mo.

GRAY, HAMILTON (Jun. '37), With Moran & Proctor, New York, N.Y. (Res., 87 Brunswick Ave., Gardiner, Me.).

GRAY, WALTER JOSEPH (Jun. '37), 3213 West St., Ames, Iowa.

GROSSO, SAMUEL JOHN (Jun. '36), Chainman, N. Y. C. Lines (Res., 1137 Grant Boulevard), Syracuse, N.Y.

GRUMBLES, MAURICE WOOTEN (Jun. '36), Office Draftsman, Austin Bridge Co. (Res., 1822 Grand Ave.), Dallas, Tex.

HALL, FRANK BELL (Jun. '36), 518 East 21st St., Baltimore, Md.

HAYWARD, HOMER JAMES (Assoc. M. '37), Engr., Shoecraft, Drury & McNamee (Res., 248 Crest Ave.), Ann Arbor, Mich.

HEINTSKILL, PETER NICOLAS (Jun. '37), 2513 North 44th St., Milwaukee, Wis.

HODGES, HERBERT LLOYD, JR., (Jun. '36), Inventory Asst., 3d Grade, Brooklyn Edison Co., 380 Pearl St. (Res., 356 Maple St.), Brooklyn, N.Y.

HOLDERBAUM, GEORGE ALBERT (Jun. '36), Insp., Underwriters Laboratories, Inc., 5240 North Winthrop Ave., Chicago, Ill.

HUGHES, HOFFMAN CASTLETON (Jun. '36), 123 G St., Salt Lake City, Utah.

JENSEN, MYRON ORVAL (Jun. '37), Junior Hydr. Engr., TVA, Knoxville, Tenn. (Res., 19 Cornelia St., Asheville, N.C.)

JEPPESEN, NORMAN LUTZ (Jun. '36), 1105 Oneida St., Joliet, Ill.

KING, WILLIAM CECIL (Jun. '36), 659 East 73d St., Seattle, Wash.

KURKCIYAN, SIMON YETVART (Jun. '36), Ceviz Sokak No. 6, Arnavut-Köy, Istanbul, Turkey.

LAFLIN, ELI FORBES (Jun. '36), Chainman, Contra Costa Canal Div., Central Val. Water Project, 414 H St., Antioch, Calif.

LEARNED, ALVAH CHESTER (Jun. '36), 1807 Glendale Boulevard, Apartment 201, Los Angeles, Calif.

TOTAL MEMBERSHIP AS OF FEBRUARY 9, 1937	
Members	5,645
Associate Members	6,021
Corporate Members	11,666
Honorary Members	24
Juniors	3,405
Affiliates	86
Fellows	1
Total	15,182

THEOPOLD, FRANCIS BERGERE (Jun. '36), 607 North Spruce St., Albuquerque, N.Mex.

TIPPENS, JOSEPH CHARLES (Jun. '37), Junior Engr., U.S. Engr. Office, 1st New York Dist., New York (Res., 1469 East 49th St., Brooklyn), N.Y.

MCGIBBON, KENNETH ARTHUR (Jun. '36), Engr., Bureau of Reclamation, Box 5, Alcova, Wyo.

MCGOWAN, JOHN (Jun. '37), Office Engr., Moffat Water Tunnel Project and Moffat Tunnel Extension Project (Res., 433 Gilpin St.), Denver, Colo.

MCMANUS, JOHN FERDINAND (Jun. '36), Eng. Insp., Eastman Kodak Co. (Res., 169 Alameda St.), Rochester, N.Y.

MALLOY, AMBROSE JOHN (Jun. '36), 1 Marble Hill Ave., New York, N.Y.

MATTHEWS, WILLIAM ALBERT (Jun. '36), 2237 Glencoe St., Denver, Colo.

MEIHOFER, ANTHONY RUDOLPH (Jun. '36), 5 West Franklin St., Baltimore, Md.

MILLER, ALFRED LAWRENCE (Assoc. M. '36), Associate Prof., Coll. of Eng., Univ. of Washington (Res., 9229 Forty-Fifth Ave., N.E.), Seattle, Wash.

MORK, LEE DALLAS (Assoc. M. '37), Instr., Civ. Eng. Dept., Washington Univ., Box 181, Washington Univ., St. Louis, Mo.

MORSE, CHARLES ADELBERT, II, (Jun. '36), 1540 Glenville Drive, Los Angeles, Calif.

MURRAY, MORRIS LUTHER, JR., (Jun. '36), Highway Designer, State Highway Dept., 1400 West 6th St., Little Rock, Ark.

NAISMITH, JAMES SHERMAN (Jun. '36), With Myers, Noyes & Forrest, Tower Petroleum Bldg. (Res., 909 East Jefferson Ave.), Dallas, Tex.

NORDENSON, TOR JULIUS (Jun. '37), 1640 West Cumberland, Knoxville, Tenn.

QUIRIN, EDWARD JOSEPH (Jun. '37), Structural Engr., Mayers, Murray & Phillips, 2 West 47th St., New York (Res., 48-35 Forty-Third St., Woodside), N.Y.

RANDALL, REX RAY (Assoc. M. '36), Civ. Engr., E. T. Minney Co.; Head, Dept. of Civ. Eng., Polytechnic Coll. of Eng. (Res., 8032 Foothill Boulevard), Oakland, Calif.

ROBINSON, PAUL EDGAR (Jun. '37), Mgr., Jay W. Robinson, R. D. 4, Auburn, N.Y.

ROSSOW, CARL JOHN (Jun. '36), Draftsman, Eng. Dept., Babcock & Wilcox Co. (Res., 416 Wooster Rd., North), Barberton, Ohio.

ROTHERAM, JOHN JACQUES (Jun. '36), Tarentum, Pa.

SACK, ADAM FRANCIS (Jun. '36), Rodman, Bethlehem Steel Co. (Res., 4532 Harford Ave.), Baltimore, Md.

SCHMICKLE, ROBERT DONALD (Assoc. M. '37), Engr., U. S. Geological Survey, St. Louis (Res., 812 North Forest Ave., Webster Groves), Mo.

SEELEY, JOHN COOLEY (Jun. '37), Asst. Engr., State Planning Comm., State Savings Bank Bldg., Ann Arbor, Mich.

SLOSS, DONALD WEBSTER, (Jan. '36), Chainman and Rodman, Met. Water Dist. of Southern California, Los Angeles (Res., 1251 North Hill Ave., Pasadena), Calif.

STACEY, WILLIAM ARTHUR (Assoc. M. '37), Field Engr., Service Bureau Am. Wood Preservers' Assoc., 2019 Conway Bldg., Chicago, Ill. (Res., 400 East 13th St., Hutchinson, Kans.).

STARR, JOHN THORNTON (Jun. '37), Surveyman, U. S. Engr. Office, Baltimore Dist., War Dept. Res., 4008½ Roland Ave.), Baltimore, Md.

STERN, ADOLPH BENJAMIN (Jun. '36), Junior Estimator and Asst. to Office Mgr., Jeffrey Mfg. Co., 30 Church St., New York (Res., 2991 Brighton 13th St., Brooklyn), N.Y.

STIRMAN, HARRY HILL (Jun. '36), Asst. Engr., Maverick County Water Control and Impvt. Dist. 1, Box 409, Eagle Pass, Tex.

SUCRE, FRANCISCO JOSE (Assoc. M. '36), Director, Bureau of Design, Ministry of Public Works, Este 4, No. 23, Caracas, Venezuela.

SULLIVAN, CHARLES WILLIAM (Jun. '36), 204 North East 15th St., Oklahoma City, Okla.

SULLIVAN, FRANCIS XAVIER (Jun. '37), 2120 Prospect Ave., New York, N.Y.

SWANSON, WALFRED ERNEST (Jun. '36), 1038 North Ardmore Ave., Los Angeles, Calif.

SWENSON, RANDOLPH AUGUST (Jun. '36), 1281 Park Pl., Brooklyn, N.Y.

TAYLOR, HENRY GEORGE (M. '37), Capt., C.E.C., U.S.N., Public Works Officer, Norfolk Navy Yard, Portsmouth, Va.

TEICHERT, FREDERICK QUAAS (Jun. '36), 1068 Forty-Fifth St., Sacramento, Calif.

THOMPSON, CLEMENT CRAIG CATON (Jun. '36), With Carnegie-Illinois Steel Co., 208 South La Salle St., Chicago (Res., 128 East Walnut St., Hinsdale), Ill.

VAN BUREN, EDGAR SEXTON (Jun. '36), Valhalla, N.Y.

VOSE, ARTHUR WILLIAMS (M. '37), Res. Engr., Insp., PWA, Boston (Res., 207 Pleasant St., Milton), Mass.

WALLACE, VIRGIL ANCIL (Jun. '36), Res. Engr., Hughes County, WPA, Morris, Okla.

WEEKS, WILLIAM ALFRED (Jun. '36), Station Master, Board of Transportation, New York (Res., 6706 Sixty-Fourth St., Ridgewood), N.Y.

WEIGHT, WILLIAM KING (Jun. '36), 6042½ Carlton Way, Hollywood, Calif.

WEISS, BERNARD SAMUEL (Jun. '36), 5546 Darlington Rd., Pittsburgh, Pa.

WERBLOW, JOSEPH MORTON (Jun. '36), Asst, Engr., P. T. Cox Contr. Co. (Res., 440 East 138th St.), New York, N.Y.

WILSON, JOHN THOMAS (Jun. '37), Deputy Building Insp., Los Angeles County Dept. of Building (Res., 478 North Ave. 56), Los Angeles, Calif.

WITHERS, CARROLL EVERETT (Jun. '36), Extension Engr., U. S. Extension Service, U. S. Dept. of Agriculture, State College, N.Mex.

WRIGHT, JAMES ANDERSON, JR., (Jun. '36), 1614 Audubon St., New Orleans, La.

MEMBERSHIP TRANSFERS

BEEBE LUCIAN HARRISON (Assoc. M. '20; M. '36), Project Engr., State Highway Dept., Hartford (Res., Quaker Hill), Conn.

BOWE, THOMAS FRANCIS (Assoc. M. '17; M. '37), Cons. Engr., 110 William St., New York, N.Y.

BROWN, CHARLES REED (Jun. '34; Assoc. M. '36), Chf. Supply Section, U. S. Engr. Office, Fort Peck Dist. (Res., 124 Milk River Drive), Fort Peck, Mont.

CHADWICK, WALLACE LACY (Assoc. M. '25; M. '37), Senior Engr., Met. Water Dist. of Southern California, 306 West 3d St., Los Angeles (Res., 2565 Monterey Rd., San Marino), Calif.

CLARK, ROY JAMES (Jun. '28; Assoc. M. '36), Contrs. Engr. and Supt., De Christopher Brothers, Peekskill, N.Y.

COLTRIN, KENNETH LOUIS (Jun. '28; Assoc. M. '36), Asst. Engr., U. S. War Dept., Bonneville Project, 627 Pittock Blk. (Res., 1406 North East 52d Ave.), Portland, Ore.

COURTER, JOSEPH ALLAN (Jun. '27; Assoc. M. '37), Engr., Long Lines Dept., Am. Telephone & Telegraph Co., 32 Sixth Ave., New York, N.Y. (Res., 71 Cedar Ave., Montclair, N.J.).

DURRETT, THOMAS JACKSON, JR., (Jun. '26; Assoc. M. '37), Dist. Director, Dist. 5, WPA of Georgia (Res., 986 Crescent Ave., N.E.), Atlanta, Ga.

HAGER, ALBERT BERTRAM (Assoc. M. '05; M. '37), Second Vice-Pres., Atlantic Gulf & Pacific Co., 15 Park Row, New York, N.Y. (Res., 3 Elliott Terrace, Rutherford, N.J.

KENNOY, JOHN SHARP (Jun. '28; Assoc. M. '36), Asst. Concrete Technician, TVA, Guntersville Dam (Res., 212 Gates St., Huntsville), Ala.

KUHN, JAMES IRWIN (Assoc. M. '16; M. '37), Associate, C. B. Rowley and Associates, 2697 Scarborough Rd., Cleveland, Ohio.

LAND, RICHARD IRVING (Jun. '27; Assoc. M. '32; M. '36), Asst. to Purchasing Agt. and Contr. Mgr., Marc Eidlitz & Son, Inc., 100 East 42d St., New York (Res., 3 Langdon Lane, Mamaroneck), N.Y.

LEWIS, ALF ALLEN (Jun. '29; Assoc. M. '37), Associate Engr., U. S. Bureau of Reclamation, Customhouse, Denver, Colo.

MACPHERSON, MALCOLM (Jun. '27; Assoc. M. '37), Asst. Engr., Delaware County Highway Dept., Delhi (Res., Stamford), N.Y.

MCDONNELL, PORTER WILSON (Jun. '28; Assoc. M. '36), Civ. Engr. and Surv., 708 Second National Bank Bldg., Toledo, Ohio.

MASON, MORRIS (Jun. '28; Assoc. M. '36), Engr., Standard Oil Co. (Indiana), Wood River Refinery (Res., 824 Lorena Ave.), Wood River, Ill.

MILBANK, REGINALD VENN (Jun. '28; Assoc. M. '36), Asst. Res. Engr., Robinson & Steinman (Res., 37 East 64th St.), New York, N.Y.

PICKWORTH, JOHN WILLIAM (Assoc. M. '21; M. '37), Cons. Engr. (Weiskopf & Pickworth), 45 West 45th St., New York, N.Y.

PIROK, JOHN NICHOLAS (Jun. '31; Assoc. M. '37), Asst. Engr., U. S. Bureau of Reclamation, 338 Fifth Ave., South, Glasgow, Mont.

PLETTA, DAN HENRY (Jun. '32; Assoc. M. '36), Asst. Prof., Applied Mechanics, Virginia Polytechnic Inst., Box 417, Blacksburg, Va.

RIVERO, JUAN RAMÓN (Assoc. M. '25; M. '36), Chf. Engr., Railways and Air Transport, Dept. of Public Works of Bolivia, Casilla 2, La Paz, Bolivia.

RUBIN, JOSEPH LEONARD (Jun. '30; Assoc. M. '36), Engr. and Supt. of Constr., Spencer, White & Prentis, Inc., New York (Res., 223 Lenox Rd., Brooklyn), N.Y.

SPEER, PAUL RUDOLPH (Jun. '35; Assoc. M. '36), Associate Engr., U. S. Geological Survey, 526 Federal Bldg., Albany, N.Y.

THAYER, GEORGE MOORE (Jun. '28; Assoc. M. '37), Asst. Hydr. Engr., U. S. Geological Survey, 406 Federal Bldg., Tacoma, Wash.

WEBER, GEORGE, JR., (Jun. '27; Assoc. M. '36), Asst. Hydr. Engr., SCS, Waco, Tex.

WEISKOPF, WALTER HERBERT (Jun. '21; Assoc. M. '25; M. '37), Cons. Engr. (Weiskopf & Pickworth), 45 West 45th St., New York, N.Y.

WELLS, JAMES BERTRAND (Jun. '13; Assoc. M. '20; M. '37), Associate Prof., Civ. Eng., Stanford Univ., Stanford University (Res., 846 Lytton Ave., Palo Alto), Calif.

WHITE, SARGENT (Jun. '31; Assoc. M. '37), Civ. Engr., 2131 North Stafford St., Arlington, Va.

REINSTATEMENTS

BRADY, SAMUEL ARTHUR, Assoc. M., reinstated Feb. 3, 1937.

HECHT, MAURICE ALBERT, Jun., reinstated Feb. 4, 1937.

HUNTER, JOSEPH GREENWOOD, M., reinstated Dec. 14, 1936.

JOVENE, NICHOLAS ANGELO, Jun., reinstated Jan. 18, 1937.

NELSON, WALTER NICHOLAS, Assoc. M., reinstated Feb. 3, 1937.

SCHNITZ, JACK LEWIS, Assoc. M., reinstated Feb. 2, 1937.

SCOTT, ALBERT LYON, M., reinstated Jan. 11, 1937.

RESIGNATIONS

ARNY, ROBERT ALLEN, Jun., resigned Jan. 13, 1937.

BERRA, ALEXANDER, JR., Assoc. M., resigned Jan. 12, 1937.

BRINKER, LOUIS EDWIN, Jun., resigned Jan. 12, 1937.

COLLINS, JOHN T., Assoc. M., resigned Jan. 11, 1937.

ELLIS, BRUCE WILLIAM, Jun., resigned Feb. 1, 1937.

EVANS, WILLIAM J., Jun., resigned Jan. 13, 1937.

HEALY, JOHN ROBERT, Affiliate, resigned Jan. 12, 1937.

HOLMES, EDWARD HENRY, Jun., resigned Jan. 19, 1937.

KUHNS, JOHN DANIEL, Assoc. M., resigned Jan. 12, 1937.

MCCABE, JOHN JOSEPH, Assoc. M., resigned Jan. 12, 1937.

MARTIN, ARTHUR, Jun., resigned Jan. 12, 1937.

NABSTEDT, HARRY MARTIN, M., resigned Jan. 13, 1937.

PRICE, TREVOR ALARIC PRYCE, Jun., resigned Jan. 13, 1937.

SIMMONS, THOMAS PARK, Assoc. M., resigned Jan. 26, 1937.

SKAU, GORDON GEORGE, Jun., resigned Feb. 2, 1937.

SLOANE, GEORGE GIST, M., resigned Feb. 1, 1937.

SOLTAU, DAVID LIVINGSTONE, Assoc. M., resigned Feb. 1, 1937.

STERN, RICHARD MORRIS, Jun., resigned Jan. 21, 1937.

THOMAS, SAMUEL ALVIN, JR., Assoc. M., resigned Jan. 19, 1937.

WOLF, WILLIAM CHARLES, Assoc. M., resigned Jan 21, 1937.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

March 1, 1937 NUMBER 3

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

BENNETT, HARRY JACKSON, Johnstown, Pa. (Age 50.) Chf. Civ. Engr., Bethlehem Steel Co., Cambria Plant. Refers to F. W. Amadon, C. N. Bainbridge, C. L. Fox, N. B. Jacobs, M. G. Mansfield, H. E. Trout, E. D. Walker.

BENSON, JOSEPH LOUIS, Atlanta, Ga. (Age 28.) Asst. Engr., Federal Power Comm. Refers to E. C. H. Bantel, B. S. Bascome, O. N. Floyd, J. L. Lochridge, R. B. McWhorter, T. C. Shuler.

BONE, ALEXANDER JAMIESON, Roslindale, Mass. (Age 35.) Asst. Prof. of Highway Eng., Massachussets Inst. of Technology, Cambridge, Mass. Refers to J. B. Babcock, 3d, H. K. Barrows, C. B. Breed, J. W. Howard, G. E. Russell.

BRADLEY, WILLIAM, White Plains, N. Y. (Age 28.) Zone Mgr., New York State WPA. Refers to F. Bagge, C. A. Gridley, F. T. James, C. H. Nichols, H. G. Wanderer, D. T. Webster.

BRITZ, HAROLD MICHAEL, Detroit, Mich. (Age 34.) Senior Structural Draftsman and Jun. Civ. Engr., City of Detroit. Refers to M. R. Fisher, E. A. Hardin, A. B. Morrill, J. W. Orton, F. E. Simpson, M. F. Wagnitz, L. C. Wilcoxen.

BROCKMAN, FREDERICK HENRY, Huntington, W. Va. (Age 27.) With U. S. Engr. Office as Jun. Engr. Refers to F. Bass, A. S. Cutler, J. P. Growdon, E. P. Schuleen, H. A. Thomas.

BROKER, CLIFFORD, Concord, N.H. (Age 33.) Superv. Engr., Bridge Dept., New Hampshire Highway Dept. Refers to A. N. Aeryns, J. W. Childs, F. E. Everett, A. W. French, H. P. Hammond, W. N. Hazen, A. Potter.

CAMPBELL, ARTHUR, Waban, Mass. (Age 47.) Bldg. Inspector, City of Newton, Mass. Refers to J. H. Black, H. P. Eddy, Jr., R. H. Ellis, H. A. Hageman, W. P. Morse, C. A. Sawyer, Jr.

CAMPBELL, JOHN RUTHERFORD, Ithaca, N.Y. (Age 35.) Engr., Resettlement Administration. Refers to C. Crandall, E. M. Fleming, E. D. Gilman, C. A. Harrell, H. B. Luther, J. E. Perry, R. Y. Thatcher.

CANTOR, ALFRED, Alameda, Calif. (Age 24.) Chf. of Party on planning survey, Nevada Dept. of Highways; Draftsman. Refers to A. W. French, J. W. Howe.

CRANE, CLAYTON O'DELL, Denver, Colo. (Age 28.) Jun. Engr., U. S. Bureau of Roads. Refers to G. D. Clyde, N. Enger, J. R. Iakisch, O. W. Israelsen, H. R. Kepner, C. Rawhouser.

DAVIES, CLARENCE WILLIAM EDWARD, Schenectady, N.Y. (Age 24.) Structural Draftsman, Gen. Elec. Co. Refers to V. G. Frisk, E. G. Semon.

DE BIASE, ANTHONY, New York City. (Age 23.) Instrumentman, Dept. of Parks. Refers to F. E. Foss, G. Morrison, E. J. Squire.

DIERKING, GEORGE THOMAS, Memphis, Mo. (Age 37.) Res. Engr. Inspector, PWA; Senior Lieut., C.E.C., U.S.N.R. Refers to E. S. Bres, J. B. Butler, C. M. Kerr, C. V. Mann, H. S. Miller, J. L. White, C. C. Whittelsey.

DILLON, FREDERICK PETER, Parker Dam, Calif. (Age 36.) Constr.'s. Engr., Winston Bros. Co., on East Iron Mt. Tunnels, Colorado River Aqueduct, and pumping plants. Refers to J. C. Agnew, F. T. Hillman, A. Jones, E. Maag, L. S. Oakes, V. L. Peugh, I. L. Tyler.

DUNLOP, JOHN ARLINGTON, Troy, N.Y. (Age 28.) Instructor in Civ. Eng., Rensselaer Polytechnic Inst. Refers to E. R. Cary, H. B. Compton, T. R. Lawson, H. O. Sharp, E. R. Wiseman.

FARLEY, RICHARD WARREN, Mt. Union, Pa. (Age 33.) Jun. Engr., U. S. Resettlement Administration, Huntingdon, Pa. Refers to C. M. Africa, G. S. Beal, W. J. Carroll, S. W. Jackson, J. H. Robinson.

FLINSCH, HAROLD VON NEUFVILLE, Minneapolis, Minn. (Age 28.) Research Asst., Hydraulics Div. Univ. of Minnesota. Refers to G. O. Guesmer, O. M. Leland, J. I. Parcel, F. C. Shenehon, L. G. Straub.

FOLEY, JOSEPH, Camden, N.J. (Age 23.) Draftsman, Pennsylvania R.R. Co., Philadelphia, Pa. Refers to W. S. Pardoe, F. P. Witmer.

FORSHAY, RAYMOND LEROY, Knoxville, Tenn. (Age 24.) Jun. Structural Engr., TVA. Refers to M. H. Benson, C. E. Mickey, R. Olafsen, J. Sorkin, R. A. Sutherland, E. S. Weed.

FOWLER, CHARLES FREDERICK, Lincoln, Nebr. (Age 36.) With Nebraska State Dept. of Roads and Irrigation in charge of state-wide highway traffic survey. Refers to A. W. Andrews, C. M. Duff, D. L. Erickson, H. J. Kesner, J. G. Mason, C. E. Mickey.

FOX, JAMES MAY, San Diego, Calif. (Age 23.) Asst. Engr., National Iron Works. Refers to T. C. Adams, R. B. Ketchum, R. R. Martel.

GARLOCK, SPRAGUE GIRVAN, Bronxville, N.Y. (Age 28.) Jun. Engr., New York State Transit Comm., New York City, Refers to H. Heins, H. M. Leon.

GATES, ALBERT JAMES, Wichita Falls, Tex. (Age 41.) Res. Engr. with Joe E. Ward, Cons. Engr. Refers to A. H. Douglass, H. R. F. Helland, C. S. Henning, Jr., J. L. Lochridge, L. M. Martin, J. Montgomery, W. J. Powell, J. E. Ward.

GROSHONG, WALTER C., Golden, Colo. (Age 32.) Res. Engr. and Asst. to Supt., United Constr. Co. Refers to A. F. Barnes, O. G. Baxter, H. S. Crocker, L. B. Feagin, C. S. McArdle, P. S. Reinecke.

HAGEDORN, HECTOR EDMUND, Brooklyn, N.Y. (Age 31.) Refers to W. M. Fife, W. F. Jenrick, W. H. Latham, C. M. Spofford.

HAVEN, ANTHONY FRANKLIN, East Chicago, Ind. (Age 32.) Structural Designer, Sinclair Refining Co. Refers to J. H. Cissel, R. E. Everett, J. S. Hess, R. H. Sherlock, J. A. Van den Broek.

HOPKINS, BRYANT LEALAND, Waterville, Maine. (Age 41.) Hydr. Engr. with Brassua Associates and Kennebec Water-Power Co. Refers to P. L. Bean, H. S. Boardman, F. C. Bowler, F. H. Mason, A. H. Morrill, M. R. Stackpole, B. T. Weston.

JENNINGS, HAL JUDSON, Denver, Colo. (Age 37.) Asst. Engr., U. S. Bureau of Reclamation. Refers to G. F. Burch, J. A. Elliott, J. S. Neibert, J. F. Partridge, J. W. Wheeler, R. B. Wright.

JOHNSON, LOYS ALMON, Knoxville, Tenn. (Age 28.) Asst. Structural Engr., TVA. Refers to H. B. Blodgett, O. Laurgaard, R. Olafsen.

KARRICK, SAMUEL NAIRN, Chicago, Ill. (Age 47.) Capt., Corps of Engrs., U. S. Army, Acting Dist. Engr., Chicago Dist. Refers to M. Elliott, C. S. Jarvis, E. M. Markham, C. R. Pettis, R. W. Putnam, M. C. Tyler, J. W. Woermann.

KRUEGER, WALTER, JR., Potsdam, N.Y. (Age 26.) Asst. Prof. of Military Science and Tactics, Clarkson Coll. of Technology, Potsdam, N.Y.; 1st Lieut., Corps of Engrs., U. S. Army. Refers to E. N. Burrows, H. Kramer, F. I. Louckes, P. S. Reinecke, F. C. Wilson, W. P. Wooten.

LARSON, HOWARD DREW, Denver, Colo. (Age 25.) Jun. Engr., U. S. Bureau of Reclamation. Refers to G. D. Clyde, O. W. Israelsen, H. R. Kepner, J. L. Savage.

LYLE, LAWRENCE HENRY, Chicago, Ill. (Age 26.) Asst. Superv. Surveyor, WPA, Project No. 122, Navy Pier. Refers to J. G. Bennett, F. G. Gordon.

LYTLE, WILLIAM JOHN, Chicago, Ill. (Age 27.) With W. E. O'Neil Constr. Co. on completion of Outer Drive Improvement, Chicago, Ill. Refers to J. A. Fahy, C. C. Hurlbut, A. S. Macgregor, W. A. Nial, J. H. Prior, F. A. Randall, O. E. Strehlow.

MALLEY, FRANK HAROLD, Boston, Mass. (Age 35.), Chf. Engr. in charge of research and design, Boston City Planning Board; 1st Lieut., Planning Branch, Q. M. Reserve, U. S. Army. Refers to A. C. Comey, A. W. Dean, A. B. Edwards, F. H. Fay, T. F. Sullivan.

MASON, MARTIN ALEXANDER, Washington, D.C. (Age 29.) Scientific Aid and Jun. Mech. Engr., National Bureau of Standards. Refers to F. W. Medaugh, C. H. Pierce, C. A. Wright.

MATEJKA, FRANKLIN KOUKOL, Denver, Colo. (Age 34.) Asst. Engr., U. S. Bureau of Reclamation. Refers to V. L. Conrad, S. F. Crecelius, B. S. Gentry, W. W. Hall, L. M. Lawson, J. L. Lytel, E. N. Noyes.

MEHTA, RAMESH SUMANT, Bhavnagar, India. (Age 30.) Drainage Engr., Public Works Dept., Bhavnagar State. Refers to T. R. Camp, H. N. Ogden, C. M. Spofford, P. H. Underwood, L. C. Urquhart, C. L. Walker.

MILLS, ALAN G., Houston, Tex. (Age 42.) Archt. Engr., Southwestern Bell Telephone Co. Refers to W. S. Bellows, J. H. Frederickson, E. A. Fretz, L. S. Holmboe, W. J. Knight, D. S. McCalman, M. F. Marks.

MONROE, CLARENCE ALBERT, Manhasset, N.Y. (Age 36.) Chf. Engr. for Levitt & Sons. Refers to A. G. Bancker, F. J. Biele, W. N. Brown, T. J. Carlile, J. L. Herber, T. E. Ringwood.

MOORE, WILLIAM JAMES, Clayton, N.Y. (Age 26.) Civ. Engr., U. S. Dept. of Interior, National Park Service, Fishers Landing, N.Y. Refers to A. A. K. Booth, O. J. Dempster. W. J. Henderson, G. E. Lommel, R. B. Wiley.

NELSON, EDWARD SEVERY, St. Paul, Minn. (Age 51.) Member of firm, C. H. Johnston, Archts. and Engrs. (being partner with C. H. Johnston, Jr., and Stirling Horner). Refers to W. N. Carey, W. L. Darling, M. S. Grytbak, G. H. Herrold, W. E. King, A. A. McCree, L. H. Sault, G. M. Shepard.

O'HEARN, JOSEPH AUGUSTINE, Muskogee, Okla. (Age 30.) Associate (Res.) Engr. Inspector, Inspection Div., Resettlement Administration, Washington, D.C. Refers to J. B. Babcock, 3d, R. B. H. Begg, G. C. Brehm, C. D. Curran, F. N. Fowler, S. C. Godfrey, E. S. Randolph, R. C. Sheldon, E. A. Taylor, A. D. Weston.

OLSON, EMERY DONALD, Ames, Iowa. (Age 21.) Refers to R. A. Caughey, F. Kerekes.

OTTO, ARTHUR LOUIS, Newark, N.J. (Age 26.) Draftsman, The Port of New York Authority. Refers to N. H. Cummings, C. W. Dunham, W. S. LaLonde, Jr.

PETERSON, VICTOR JOEL, Detroit, Mich. (Age 32.) Asst. Res. Engr. Inspector, PWA, Inspection Div. Refers to W. H. Adams, W. L. Couse, D. C. Fenstermaker, M. F. Ohr, D. R. Wells.

PETT, JOHN FLOYD, Decatur, Ga. (Age 30.) Associate Engr., National Park Service, Regional Office, Atlanta, Ga. Refers to J. P. Bondurant, T. E. Collins, E. Fleming, H. N. Lendall, C. E. Pett.

PILLEY, EDWARD FEARN, Levelland, Tex. (Age 30.) Res. Engr., Texas Highway Dept. Refers to G. A. Field, W. H. Garrett, L. C. Ingram, Jr., T. B. Ingram, F. B. Ogle, H. N. Roberts, Jr., J. E. Taylor.

PURINGTON, DONALD VARNEY, Center, Tex. (Age 36.) Res. Engr., Texas State Highway Dept. Refers to D. C. Greer, T. E. Huffman, V. G. Koch, J. T. L. McNew, C. T. Nitteberg, G. G. Wickline, M. E. Worrell, J. M. York.

QUILTY, PATRICK, New York City. (Age 64.) Deputy Chf. Engr. (Acting Chf. Engr.), Dept. of Water Supply, Gas & Electricity. Refers to W. W. Brush, J. Goodman, H. B. Machen, F. B. Nelson, J. C. Riedel, W. J. Shea.

RANDALL, GIFFORD MYRON, Berkeley, Calif. (Age 21.) Refers to C. Derleth, Jr., G. E. Troxell.

RICCIO, JOSEPH GEORGE ANTHONY, West Springfield, Mass. (Age 27.) Surveyman, U. S. Engr. Office, Providence, R.I. Refers to E. W. Crawley, W. R. Vawter, H. A. Whitcomb, M. J. Young.

RITCHIE, RAYMOND DARROW, New York City. (Age 43.) Bldr. on general contracting. Refers to O. P. L. Albert, W. W. Chapin, F. R. W. Cleverdon, W. H. Latham, F. O. Price, W. von Phul.

SCHMECKPEPER, HENRY LUDOLF, West Brookfield, Mass. (Age 33.) With the Arthur A. Johnson Corporation, Long Island City, N.Y., as Asst. Engr., Quabbin Dike, Enfield, Mass. Refers to F. A. Barnes, W. Beattie, E. A. Groves, E. G. Haines, C. A. Leighton, C. B. Molineaux.

SCHNEIDER, GEORGE RUSSELL, Denison, Tex. (Age 42.) Asst. Engr., U. S. Engr. Dept. Refers to A. L. Alin, T. S. Burns, G. A. Hathaway, J. D. Justin, G. H. Matthes.

SENECAL, HENRY JESS, SR., Hellertown, Pa. (Age 40.) With Bethlehem Steel Co., Bethlehem, Pa. Refers to E. F. Ball, E. L. Durkee, P. A. Franklin, J. Jones, R. MacMinn, G. L. Taylor.

SOUTHERLAND, HENRY DELEON, JR., Knoxville, Tenn. (Age 25.) Asst. Eng. Aide, TVA. Refers to J. S. Bowman, D. E. Donley, C. M. Strahan, G. E. Tomlinson, W. L. Voorduin, D. M. Wood.

STACKHOUSE, JOHN LLEWELYN, Olympia, Wash. (Age 37.) Constr. Asst., Washington State Highway Dept. Refers to C. C. Arnold, F. C. Dunham, C. D. Forsbeck, R. C. Knapp, L. V. Murrow, R. K. Tiffany.

STRONG, RALPH JOHN, Providence, R.I. (Age 23.) Refers to C. D. Billmyer, J. L. Murray.

STULL, JOSEPH SMITH, Eltingville, N.Y. (Age 54.) Senior Designing Engr., Board of Water Supply, New York City. Refers to R. W. Armstrong, A. B. Hager, T. Merriman, J. F. Sanborn, W. R. Scanlin, W. E. Spear, C. H. Stevens.

THOMAS, CYRIL, Natoma, Calif. (Age 33.) Civ. Engr. with Natomas Company. Refers to W. A. Perkins, A. G. Proctor, L. B. Reynolds, N. Silsbee, J. B. Wells, H. A. Williams.

THRAPP, HARRISON FRANCIS, Fountain City, Tenn. (Age 27.) Jun. Hydr. Engr., TVA, Knoxville, Tenn. Refers to J. S. Bowman, F. M. Dawson, D. E. Donley, D. W. Mead, D. M. Wood.

WALBRIDGE, SMITH STARR, Woodside, N.Y. (Age 30.) Jun. Asst. Engr., State Dept. of Public Works, Div. of Highways, Babylon, N.Y. Refers to H. Grand, G. W. Harvey, J. F. Kern, W. K. Koch, W. H. Latham.

WALLACE, HILLFORD RICHARD, Spokane, Wash. (Age 43.) Reconnaissance and Locating Engr., State Dept. of Highways. Refers to C. C. Arnold, E. C. Dohm, C. H. Eldridge, L. V. B. Murrow, H. E. Phelps.

WAX, LESLIE, Brooklyn, N.Y. (Age 27.) Estimator and Supervisor with T. Fred. Jackson, Inc., New York City. Refers to A. N. Aeryns, H. R. Codwise, H. P. Hammond, A. K. Johnson, L. F. Rader, E. J. Squire.

WELLS, WILLIAM LEONIDAS, Vicksburg, Miss. (Age 26.) Jun. Engr., U. S. Waterways Experiment Station. Refers to S. J. Buchanan, E. M. Durham, Jr., G. Gilboy, K. C. Reynolds, C. M. Spofford, H. D. Vogel.

WHITE, FRANK EDWARD, Brooklyn, N.Y. (Age 37.) Civ. Engr., acting as Res. Engr. Inspector, PWA, New York City. Refers to A. M. N. Blamphin, H. Fishgrund, T. H. Jones, R. S Raaberg, G. H. Sager, Jr., H. C. T. Toensfeldt.

WISE, WILLIAM SPATZ, West Hartford, Conn. (Age 41.) With State Water Comm., Hartford, Conn. Refers to H. W. Buck, N. B. Jacobs, M. G. Mansfield, A. T. Ricketts, W. J. Scott.

WORSHAM, WALTER BOATMAN, Springfield, Ill. (Age 49.) Asst. Engr. of Materials, Illinois Div. of Highways. Refers to C. H. Apple, G. H. Baker, R. L. Bell, R. R. Benedict, G. F. Burch, H. F. Clemmer, J. S. Crandall, W. E. Dawson, E. D. Dryfoose, C. R. French, C. M. Hathaway, A. H. Hunter, C. E. Morgan, M. C. Noble, H. W. Russell, W. N. Schroeder, F. T. Sheets, C. M. Slaymaker, C. C. Wiley.

WRIGHT, WILLIAM WALTER, Utica, Ill. (Age 27.) Dredge Inspector, U. S. Engr. Dept. Refers to J. G. Bennett, J. J. Doland, M. L. Enger, W. C. Huntington, F. E. Richart.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

ALLEN, HAROLD, Assoc. M., Topeka, Kans. (Elected Dec. 15, 1924.) (Age 42.) Engr. of Materials, Kansas State Highway Comm. Refers to H. D. Barnes, W. V. Buck, F. W. Epps, C. I. Felps, G. S. Knapp, M. W. Watson, M. A. Wilson.

BLASER, ARTHUR FREDERICK, Assoc. M., Cleveland, Ohio. (Elected May 31, 1916.) (Age 60.) Chf. Engr., City Street R. R. Commrs'. Office. Refers to W. P. Brown, R. L. Harding, J. H. Herron, R. Hoffmann, O. W. Irwin, R. H. Lee, W. J. Watson.

BLOXTON, CONWAY RUSSELL, Assoc. M., Atlanta, Ga. (Elected Assoc. M. Dec. 15, 1924.) (Age 40.) Dist. Engr., American Inst. of Steel Constr., New York City. Refers to L. F. Bellinger, W. J. Camlin, W. J. Carrel, F. H. Frankland, E. Harsch, J. S. Watkins.

CROSETT, ALEXANDER DAVIS, Assoc. M., Pelham, N.Y. (Elected Oct. 2, 1922.) (Age 48.) Cons. Engr., New York City. Refers to A. J. Barzaghi, A. M. Bouillon, E. J. Moore, J. P. H. Perry, A. W. Stephens, J. E. Wadsworth, A. Weymouth.

DIEHL, PAUL ADAM, Assoc. M., Kansas City, Mo. (Elected Nov. 15, 1926.) (Age 44.) Chemist and Engr. with Black & Veatch. Refers to E. B. Black, J. F. Brown, A. P. Learned, F. M. Veatch, N. T. Veatch, Jr.

FEAGIN, LAWRENCE BAKER, Assoc. M., St. Louis, Mo. (Elected Junior Dec. 15, 1924; Assoc. M. April 25, 1932.) (Age 37.) Senior Engr., U. S. Engr. Dept., being Executive Asst. to Officer in charge, Lock 2, Dam. Sec., St. Louis Dist. Refers to M. Elliott, A. F. Griffin, W. H. McAlpine, P. S. Reinecke, C. A. D. Young.

HOSTRUP, CHRISTIAN FREDRICK, Assoc. M., Los Angeles, Calif. (Elected Nov. 10, 1930.) (Age 41.) Pacific Coast Manager, The Pitometer Co. of New York. Refers to E. S. Cole, C. M. Hoskinson, R. Norris, G. N. Schoonmaker, O. A. Stone, J. A. Van den Broek, E. K. Wilson.

JOHNSON, ROBERT COLTON, Assoc. M., Milwaukee, Wis. (Elected Nov. 15, 1926.) (Age 42.) Asst. to State Director, N.E.C. Refers to J. L. Ferebee, A. E. Lindau, C. S. McArdle, D. W. Mead, F. E. Turneaure, L. F. Van Hagan, C. S. Whitney.

PORZELIUS, ALBERT FREDRICK, Assoc. M., Chattanooga, Tenn. (Elected Junior Jan. 7, 1913; Assoc. M., April 7, 1915.) (Age 50.) Supt., City Water Co. of Chattanooga. Refers to F. R. Berry, C. A. Betts, G. W. Biggs, Jr., H. F. Juengst, C. E. McCashin, W. H. Sears, D. H. Wood.

ROSENBERGER, RAYMOND JOYCE, Assoc. M., Washington, D.C. (Elected Junior Oct. 12, 1925; Assoc. M. Nov. 11, 1929.) (Age 35.) Engr.-Examiner, Chf. of Planning Sec., Projects Div., PWA. Refers to H. G. Baity, T. A. Cox, Jr., C. E. Grubb, T. F. Hickerson, R. M. Trimble, C. E. Waddell, S. H. Wright.

THAXTON, RUFUS CARROLL, Assoc. M., Sacramento, Calif. (Elected March 15, 1926.) (Age 48.) Cost Engr., U. S. Bureau of Reclamation, Central Valleys (Calif.) Project. Refers to S. F. Crecelius, S. O. Harper, I. E. Houk, J. L. Savage, R. F. Walter, W. R. Young.

FROM THE GRADE OF JUNIOR

ATTRIDGE, WILLIAM JAMES, Jun., Rigby, Idaho. (Elected Oct. 24, 1932.) (Age 32.) Jun. Engr. (Hydrographer), U. S. Bureau of Reclamation. Refers to H. F. Bahmeier, J. E. Buchanan, I. N. Carter, L. Crandall, I. C. Crawford.

BELL, FRANCIS MURDOCH, Jun., St. Louis, Mo. (Elected March 15, 1926.) (Age 31.) Asst. Engr., Water Resources Branch, U. S. Geological Survey. Refers to H. C. Beckman, E. D. Burchard, N. C. Grover, J. C. Hoyt, C. G. Paulsen, A. B. Purton, T. Saville, F. M. Veatch.

CLOUDMAN, CHARLES GREENLEAF, Jun., Brooklyn, N.Y. (Elected Oct. 30, 1933.) (Age 31.) Asst. Engr., Order and Contract Dept., Permutit Co., New York City. Refers to C. D. Billmyer, O. L. Burdett, J. R. Crocker, J. M. Hardesty, J. L. Murray.

COOK, WARREN STEWART, Jun., Ames, Iowa. (Elected Oct. 14, 1930.) (Age 32.) Bridge Designer and Shop Inspector, Bridge Dept., Iowa Highway Comm. Refers to L. T. Andrus, R. A. Caughey, L. W. Cox, W. C. Ohlsen, N. Welden.

CUNNINGHAM, HUGH TANQUARY, Jun. Mt. Carmel, Ill. (Elected Oct. 10, 1927.) (Age 32.) County Supt. of Highways, Wabash County, Ill. Refers to W. M. Bassett, L. V. Branch, H. T. Larsen, W. von Phul, A. W. Wand, C. C. Wiley.

DICKEY, WALTER LINNAEOUS, Jun., Los Angeles, Calif. (Elected March 28, 1932.) (Age 29.) Structural Draftsman, Los Angeles Union Pacific Terminal (Union Depot No. 225). Refers to J. C. Albers, R. L. Anderson, F. J. Converse, R. R. Martel, W. W. Michael, F. Thomas, C. D. Wailes, Jr.

EHLERS, RALPH BURLIN, Jun., Midland, Mich. (Elected Dec. 5, 1927.) (Age 32.) Designing Engr., The Dow Chemical Co. Refers to R. W. Abbott, A. J. Decker, W. R. Drury, W. C. Hoad, R. L. McNamee, N. K. Sheppard, E. C. Shoecraft, G. F. Wyllie.

FELDMAN, MAX BERNARD, Jun., Pittsburgh, Pa. (Elected Junior July 11, 1927.) (Age 32.) Chf. Estimator, H. H. Robertson Co. Refers to A. A. Brown, F. J. Evans, F. M. McCullough, J. R. Sexton, C. B. Stanton, H. A. Thomas.

FOLSOM, JAMES FORREST, Jun., West Brookfield, Mass. (Elected Jan. 26, 1931.) (Age 32.) Jun. Civ. Engr., Metropolitan Dist. Water Supply Comm. of Massachusetts. Refers to H. P. Burden, F. T. Crowe, F. E. Fahlquist, K. R. Kennison, W. W. Peabody, F. E. Winsor, E. H. Wright.

GOMEZ-PEREZ, FRANCISCO, Jun., Mexico, D.F., Mexico. (Elected May 13, 1929.) (Age 32.) Engr. of Specifications, Eng. Dept., Mexico National Irrigation Comm.; Asst. Prof. Structural Design and Bridge Design, Higher School of Constr., Federal Dept. of Education. Refers to G. D. Camp, A. Peimbert, L. Perez Castro, S. W. Stewart, A. Weiss, C. P. Williams.

HERMIDA, THOMAS JOSEPH, Jun., Berkeley, Calif. (Elected Oct. 29, 1934.) (Age 32.) Jun. Engr. and Asst. Engr. Inspector, Resettlement Administration. Refers to R. L. Barbehenn, H. E. Burr, H. R. Gabriel, F. Lavis, F. J. Sette, C. H. Splitstone.

JOHNSON, OLIVER ARTHUR, Jun., Vicksburg, Miss. (Elected Oct. 10, 1927.) (Age 32.) Jun. Engr., U. S. Engr. Office. Refers to O. G. Baxter, W. M. Borgwardt, F. J. Brown, G. R. Clemens, A. H. Fuller, N. R. Moore.

JOHNSTONE, DON, Jun., Plainfield, N.J. (Elected Jan. 25, 1932.) (Age 27.) On Editorial Staff, American Society of Civil Engineers, New York City. Refers to G. B. Archibald, J. J. Doland, G. R. Rich, B. W. Steele, H. D. Vogel, S. Wilmot.

LATHAM, GEORGE ROBERT, Jun., East Orange, N.J. (Elected Nov. 15, 1926.) (Age 32.) Designer and Checker and Squad Leader, Phoenix Eng. Corporation, New York City. Refers to W. E. Brown, D. W. Cole, J. Fertik, A. T. Larned, W. S. Merrill, G. H. Seybolt, L. A. Whitsit.

MARCROFT, JOHN CLIFFORD, Jun., Honolulu, Hawaii. (Elected Dec. 3, 1928.) (Age 32.) Associate Civ. Engr., U. S. Engr. Dept. Refers to G. R. Brooks, R. L. Egenhoff, R. D. Goodrich, P. S. Jones, G. McFadden, B. F. Rush, O. G. Stanley.

MOORE, MORRISON BERT, JR., Jun., Aliquippa, Pa. (Elected June 6, 1927.) (Age 32.) Asst. Engr., U. S. Engrs., Pittsburgh, Pa. Refers to N. B. Jacobs, W. S. Lohr, M. G. Mansfield, M. R. Scharff, E. S. Taub.

NIEMAN, ARTHUR ROBERT, Jun., North Bonneville, Wash. (Elected March 10, 1930.) (Age 33.) Night Supt. and Field Engr., Columbia Constr. Co., Bonneville, Ore. Refers to H. F. Anthony, J. J. Doland, A. Donaldson, W. C. Huntington, W. W. Laxton, H. K. Murner.

PEEBLES, ARCHIBALD, Jun., Vancouver, B.C. (Elected April 22, 1935.) (Age 32.) Instructor, Univ. of British Columbia. Refers to E. A. Cleveland, A. H. Finlay, J. N. Finlayson, F. Kerekes, E. G. Matheson, R. A. Moyer, S. Thompson.

PITNEY, HARVEY MARSHALL, Jun., Bethlehem, Pa. (Elected Oct. 14, 1930.) (Age 32.) Estimator and Designer, Bridge Dept., Bethlehem Steel Co. Refers to J. R. Blondin, G. A. Caffall, E. L. Durkee, D. S. Gendell, Jr., L. L. Martin.

REMLEY, NORMAN WILLIAMS, Jun., Jefferson City, Mo. (Elected Nov. 15, 1926.) (Age 32.) Designer, Missouri State Highway Dept. Refers to R. W. Brooks, C. W. Brown, F. W. Harvey, A. L. Hyde, J. H. Long, H. K. Rubey.

ROHRER, GEORGE HILLDRING, Jun., Mountain Lakes, N.J. (Elected Feb. 10, 1936.) (Age 32.) Constr. Engr. and Asst. Supt. with Geo. Peterson, Inc. Refers to D. C. N. Collins, H. R. Gabriel, H. Hartwell, S. Johannesson, E. B. Karnopp.

SANDERSON, THEODORE HAROLD, Jun., Chicago, Ill. (Age 32.) Asst. Engr. and Representative, Metallurgical Dept., Carnegie-Illinois Steel Corporation. Refers to T. Bloecher, Jr., N. M. Hench, R. T. Regester, A. F. Reichmann, J. T. Thompson.

SMITH, ROBERT TRUMBULL, Jun., Minneapolis, Minn. (Elected Dec. 22, 1930.) (Age 32.) San. Engr. and Dist. Mgr., Wallace & Tiernan Co., Newark, N.J. Refers to A. C. Beyer, C. Derleth, Jr., E. Dolliver, H. S. Hutton, F. G. Nelson, G. D. Peet, H. G. Rogers, J. Wilson.

TEMPLIN, NEWTON HENRY, Jun., Downey, Calif. (Elected July 16, 1928.) (Age 32.) Civ. Engr. Grade III, Los Angeles County Road Dept. Refers to W. D. Armstrong, E. A. Burt, O. F. Cooley, B. A. Hill, G. W. Jones, W. W. Michael.

THEUER, ARTHUR ULRICH, Jun., Washington, D.C. (Elected Dec. 3, 1928.) (Age 32.) Asst. Materials Engr., U. S. Bureau of Standards. Refers to D. E. Parsons, L. B. Reynolds, E. C. Thomas, C. B. Wing, C. A. Wright.

TSATSOS, ALEXANDER GEORGE, Jun., Kephissia, Greece. (Elected Oct. 30, 1933.) (Age 31.) Asst. Gen. Mgr., Ertha Co. of Athens, Greece. Refers to R. W. Gausmann, G. A. Halkiopulos, W. J. Judge, R. H. Keays, P. D. Troxler.

WALSH, THEODORE MICHEAL, Jun., Los Angeles, Calif. (Elected Feb. 24, 1931.) (Age 32.) With Los Angeles County as Civ. Engr., Grade II and Chf. of Party on topographic surveys. Refers to C. E. Arnold, C. S. Haig, A. Jones, O. de la V. Keese, A. G. Pickett.

WOOD, HAROLD AARON, Jun., Albuquerque, N. Mex. (Elected Nov. 28, 1932.) (Age 32.) Jun. Engr., United Pueblos Agency, in charge of subjugation work, design of irrigation systems and structures. Refers to E. L. Barrows, P. S. Fox, B. Johnson, H. C. Neuffer, R. H. A. Rupkey, A. N. Thompson.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.